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HEALTH SCIENCE AND HEALTH EDUCATION

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Photograph of a monument in Paris representing a boy wrestling with a rabid dog and commemorating Pasteur's great victory over rabies or hydrophobia. (See story on page 100.) Standing beside the monument is the boy, now a grown up man, whose life was saved by the vaccine. The man is janitor in the Pasteur Institute which is seen in the background.
(By courtesy of American Medical Association.)

HEALTH SCIENCE AND HEALTH EDUCATION

FOR COLLEGE STUDENTS AND TEACHERS IN TRAINING

BY

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NEW YORK

JOHN WILEY & SONS, Inc.

London: CHAPMAN & HALL, Limited

1929

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DEDICATED TO

MY FATHER AND MOTHER

WHOSE PARTS IN THE AFFAIRS OF LIFE HAVE NOT BEEN SPECTACULAR,
WHOSE POSSESSIONS OF THIS WORLD'S GOODS HAVE NOT BEEN LARGE,
BUT WHOSE WHOLESOME CHARACTER, IDEALS AND SACRIFICE
HAVE MADE THIS HUMBLE EFFORT POSSIBLE

101848.

PREFACE

This book has grown out of a course taught in state teachers college and university during the past ten years. Although it consists chiefly of personal, home and community hygiene, it embraces considerably more than hygiene.

The motives which actuated the writing of this text may be stated as follows:

(1) To pitch the teaching of hygiene upon a simple epidemiological and bacteriological basis, so far as possible. Hygiene and sanitation were born with Pasteur.

(2) To make health science an objective study. This is the excuse for including Part IV (Projects in Personal Health and Laboratory and Field Exercises). It is believed that objective teaching is even more important in the teaching of health science than in that of the other sciences, for it is desired that health knowledge acquired by the student be carried over into daily life as dependable health habits and attitudes of mind. Professor C. E. Turner says correctly that "In health, as in religion, there is no direct correlation between knowledge and action." Project teaching has proven a useful instrument in converting health knowledge into health behavior.

(3) To eliminate much primer type of personal hygiene which the student learned, or should have learned, in the public schools and to substitute some subject matter not so widely used but better adapted to provoke thought in the college student. An effort has been made to eliminate many childish injunctions and unnecessary detail. Rather than attempt to impart dogmatic rules for hygienic conduct, it is preferred to instruct in scientific principles and to teach by suggestion. This latter has been attempted specially in Part I (Common Preventable Diseases and How They Are Prevented).

(4) To give the student greater opportunity to acquire ideas relating to community hygiene, as well as personal hygiene. Where in all the world of modern subject matter is there any which is better suited than community hygiene for making an intelligent citizen? What subject matter lends itself more forcibly for developing in the student a realization of his obligation toward the rest of his community?

Besides, it is community hygiene rather than personal hygiene which the student prefers at this stage of his development. He is now a thoroughly socialized creature and is deeply interested in social hygiene, using the term in a broader sense and not to indicate the venereal diseases specially. Personal hygiene at this stage is properly taught through the community hygiene approach. Otherwise, personal hygiene is monotonous to the college student for it has been fed to him through all his school career.

(5) To present personal, home and community hygiene woven together in a single mass of subject matter, as they naturally are. In their natural functioning the three phases of hygiene are inseparable. Any attempt to take them apart and present them separately results in a distinct loss to the student.

(6) To place special emphasis on the science of building up body resistance to common infections, a fundamental phase of hygiene too much neglected in the past.

(7) To make foods, nutrition and the method of formulating a balanced diet for oneself an outstanding feature. Is it true that heredity and nutrition are the two most important factors in the making of a man or woman?

(8) To serve as a scientific basis in the preparation of prospective teachers for their parts in the modern school health program. In the sections of Part I relating to common infectious diseases of children the early signs and symptoms of those diseases are given. Suggestions for exclusion from school and for re-admittance also are offered. A chapter on the modern school health program is included. And a number of the practical exercises in Part IV have been specifically designed for prospective teachers.

W. A. B.

NORMAN, OKLA.

ACKNOWLEDGMENTS

THE author wishes to acknowledge his indebtedness to several published works upon which he has drawn heavily for material in this text. Those which have been most used are the following: Professor M. J. Rosenau's "Preventive Medicine and Hygiene," D. Appleton & Co.; "The Control of Communicable Diseases," published by American Public Health Association, New York; Wood and Rowell's "Health Through Prevention and Control of Diseases," World Book Co.; McCollum and Simmonds' "Food, Nutrition and Health," published by the authors; and Professor E. O. Jordan's "General Bacteriology," W. B. Saunders Co.

The authors and publishers of a number of works have generously granted permission to quote passages and reproduce figures from their publications. Acknowledgment is made of their courtesy in connection with each passage quoted or cut reproduced.

Much gratitude is felt by the author for his wife's consistent tutoring during several years past in matters relating to dietetics and nutrition. From those fields she has brought many helpful suggestions.

The author is also much indebted to several of his colleagues who have aided him with subject matter related to their respective fields of study. Dr. Gayfree Ellison's many years of experience in teaching hygiene have lent much aid and encouragement to the author. Other colleagues who have generously aided and encouraged are: Assistant Dean L. A. Turley, pathology; Dr. Mark R. Everett, biochemistry and foods; Dr. J. M. Essenberg, heredity; Dr. J. M. Thuringer, embryology; Dr. Alma J. Neill, physiology; and Dr. Ray M. Balyeat, hay-fever and asthma.

Dr. Clyde H. Walker, dental surgeon, has kindly given a number of helpful suggestions relating to oral hygiene.

Dr. John Sundwall, Director of School of Hygiene and Public Health, University of Michigan, reviewed the preliminary manuscript and made a number of suggestions which have been incorporated. His very excellent paper, "The Teaching of College Hygiene," has been consulted frequently in the course of the preparation of the manuscript. Furthermore, the author within recent years had the privilege of visiting Dr.

Sundwall's School of Hygiene and Public Health and some ideas obtained during that visit have influenced the content and method of treatment.

Finally, the author is deeply obligated to Mrs. Naomi Dodson Howard, who with much sacrifice has rendered valuable aid in the preparation of the manuscript.

W. A. B.

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INTRODUCTION

David Harum thought, "A reasonable amount of fleas is good for a dog. They keep him from broodin' on being a dog." With regard to physical defects and disease we have in the past adopted an attitude of mind and philosophy similar to that of David Harum. We have even argued that disease is Heaven-sent and not to be escaped. Intimate familiarity with illness and human suffering has bred a remarkable indifference and complacence. But in recent years we have awakened sufficiently to ask a question.

Is There a Need of Health Training? Will health training actually benefit me? Let the following facts give their own answers.

The report of the Roosevelt Commission on National Vitality stated that there were 600,000 premature deaths each year in the United States; that $1\frac{1}{2}$ billion dollars per year was the cost of these unnecessary deaths; that 15 years is lost to the average life because of these needless deaths; that 3 million cases of sickness exist in the United States each day and one-half of them unnecessary. More recently Mr. Herbert Hoover's Committee on Waste in Industry reported that the loss of the nation from preventable diseases each year was about $1,800,000,000.

Merely "feeling bad" costs the people of the United States many millions per year, according to Professor Irving Fisher of Yale University.

During the recent World War nearly one-third of the men drafted in the United States were either rejected because of ill health or physical defects, or they were assigned to special type of work more suited to their physical shortcomings. According to authorities the majority of these shortcomings were preventable or remediable.

Typhoid fever is almost wholly preventable, as has been actually shown in practice by many communities in the United States. Yet numerous other communities to-day experience 20 to 30 times as much typhoid in proportion to population as the more advanced communities.

The insane and paupers of Wisconsin cost $13,000,000 per year. The same classes of persons require one-fourth of all the taxes collected by New York State.

It is said that some 20 millions of persons in the United States are

scrub stock mentally. " Wooden legs are not inheritable, but wooden heads are " (Conklin). Wooden heads are preventable.

Nearly 200 millions of dollars are spent annually in the United States for " patent " medicines—which were never patented. Up to the year 1927, 51 million bottles of " Tanlac " alone had been sold, at one dollar per bottle, according to the makers of that nostrum.

The author is personally acquainted with a former governor of one of our states, who is now a member of one of the most important commissions of the federal government, who possesses three degrees from universities, who is president of the board of trustees of a university, but who, with all his learning in literature and law, labors under the delusion that he suffers from " subluxations " of the spine and takes " adjustments " for them. The author also has known college professors who suffered " subluxations " of the vertebrae—acquired in their strenuous lives as college professors. These professors in college seek the services of pseudo-medical men, the average of whom is not so much as a high-school graduate.

Such persons mentioned, during their college careers gave sufficient study to literature to become literary *sensed* and are capable of recognizing literature by the reading of a single page. But their training was so devoid of science that they now find themselves not science sensed and, furthermore, find themselves incapable of sensing medical or scientific fraud in the most blatant forms. So long as governors and college professors continue to display such exhibitions of credulity and gullibility, we feel fully justified in assuming that there is a need for scientific health training in the schools and colleges.

But Does Health Education Offer Possibilities?—We judge the future by past history. Even with the spasmodic and sporadic effort of the past toward popular health education the scattered results indicated below have been attained:

The tuberculosis death rate in 1904 was 200 deaths per 100,000 population in the United States as a whole; in 1924 the tubercular death rate was only 97 per 100,000 population.

In 15 years the typhoid death rate in 57 leading cities of the United States has been reduced till now it is only one-sixth as high.

The little city of Framingham, Mass., put on an intensive health campaign. In a short five-year period of special effort Framingham reduced its infant death rate 40 per cent and its tuberculosis death rate 50 per cent.

In New York City in 1877, 105 children of each thousand between 1 and 5 years of age died; in 1923 only 20 in a thousand at this age died.

In the year 1900 the industries of the United States lost 13 days per employee for illness; in 1923 only 7 days per person were lost.

In the year 1800 the average life in the United States was 33 years; to-day the average length of life is 58.

These few instances of progress show what could be done with even half-hearted spasmodic effort. What might have been the results had health training pervaded all the schools—grade schools, high schools, and colleges? Health is, or should be, the most fundamental concern of school. A famous German philosopher made a suggestion to Bismarck which ran something like the following: What you would have in the life of a nation, first put in the schools of the people.

Can the College Student Promote His Personal Health?—But can I, a college student, improve my physical efficiency and thus promote my chance of success in life?

What specific knowledge and practices can I acquire which will aid me in warding off infections and disease in the largest number of instances possible for me to attain?

What are the practices which I may follow in order to promote a sense of good feeling and high spirits which mean so much in attaining success?

What definite mental practices may I establish as habits and which may promote my efficiency, happiness, and opportunity for success?

There are many very specific personal habits and attitudes of mind which may be cultivated and which promote one's "realization of the highest physical, mental, and spiritual possibilities." And the attainment of such realization through personal habits and mental attitudes vastly enhances one's opportunity in attaining life's highest offerings.

Learning to Evaluate.—In this day we see many persons meagerly or partially trained in health science, just sufficiently informed or misinformed to get excited. The mental agitation of such persons revolves about fads and hobbies of secondary importance, or of no importance, to the entire neglect of other matters of most fundamental nature. Thus we have the fresh-air fanatics who have never considered that air is air wherever it be; the germ-specter alarmists, who get alarmed at the wrong situations; the vegetarians; the mastication ritualists; the big-muscle zealots; and the barrel-a-day water advocates. A very pertinent consideration for the college student is the acquirement of sufficient information and training in the *principles* of health science that he may be enabled to evaluate for himself matters of secondary importance and of primary importance.

PART I

COMMON PREVENTABLE DISEASES AND HOW THEY ARE PREVENTED

HEALTH SCIENCE AND HEALTH EDUCATION

CHAPTER I

DISEASE-PRODUCING MICROORGANISMS

When the term "preventable" is used in connection with infectious diseases it is used as a relative term, that is, in a relative sense, for some communicable diseases are more preventable than others. Typhoid fever, for instance, is far more preventable than pneumonia, under present knowledge. Yet we speak of pneumonia as a preventable disease, because it undoubtedly is preventable to a considerable degree.

But before one may come to an understanding of the prevention of the common communicable diseases to which man is susceptible, it is necessary to gain some elementary understanding of the causal agents whose presence in the human body produces those diseases. It therefore becomes necessary to devote one chapter to a brief review of the characteristics and habits of the microorganisms or germs which parasitize man and induce those derangements of functions of the body which we call disease. It should be understood, however, that not all diseases of man are produced by germs, notable exceptions being diabetes and probably cancer. About 80 per cent of all deaths are due to germ diseases.

Classes of Disease-Producing Microorganisms.—The term "germs," as applied in connection with communicable diseases of man, is an inclusive one. It embraces parasitic members of several groups of microorganisms—the bacteria, yeasts, molds, protozoa, spirochaetes, and two parasitic groups of worms. Of the six groups named, the protozoa and worms are animal organisms parasitic in man; the bacteria, yeasts, and molds are parasitic plant organisms; and the spirochaetes possess characteristics common to both plants and animals, belonging strictly to neither. But not all members of any one of the six groups are parasitic in man. Most species in each group do not parasitize the human body—fortunately, from man's point of view. We

shall proceed to consider each of the six groups separately. The bacteria being the most important of the groups, and simplest, we shall discuss them first and most extendedly.

1. THE BACTERIA

Bacteria Defined.—Bacteria are one-celled plant organisms, microscopic in size. That is, the bacterium is a tiny plant whose body has no cross-walls through it to divide it into two or more structural units or cells. The living substance or **protoplasm** of the organism is surrounded by a single-cell wall, or more exactly, by a single-cell membrane. There is no *demonstrable* nucleus in the cell body, a fact which distinguishes bacteria from other groups of microorganisms to be discussed later. Many of the bacteria have slender hair-like projections, called **flagella**, extending from their body surfaces. The flagella enable the bacterium to move, the locomotion being produced by the waving of the flagella in the fluid or water in which the bacterium happens to be living. Bacteria multiply by simple **transverse division**, the one cell thus becoming two cells. The method of multiplication or reproduction will be described later.

Classes of Bacteria.—According to form or shape of bacteria, they are arranged into three general classes: **bacilli** (singular, *bacillus*); **spirilla** (singular, *spirillum*); and **cocci** (singular, *coccus*).

Bacilli (Fig. 1) are rod-shaped, some being relatively long rods, others quite short. Bacilli may be either single and separate or they may be attached end to end, thus forming chains. Examples of diseases produced by bacilli are typhoid fever, diphtheria, and tuberculosis.

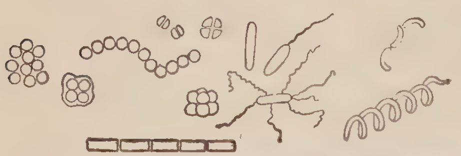


Fig. 1.—Forms of bacteria. (From Jordan's "General Bacteriology," W. B. Saunders & Co.)

Spirilla (Fig. 1) are spiral or corkscrew shaped, as the name indicates. Not many common diseases are produced by spirilla, Asiatic cholera being one, which, however, is not common in the United States.

Cocci (Fig. 1) are spherical in form. The Class Coccus is further divided into subclasses: (1) *Streptococci*, which are spheres arranged in chains. Examples of diseases in man caused by streptococci are scarlet fever, and most cases of so-called blood poisoning. (2) *Diplococci* are spheres grouped in pairs. Disease examples: most cases of lobar pneumonia, gonorrhea, and the epidemic type of menin-

gitis. (3) *Staphylococci* are spheres arranged irregularly in sheets, a single layer in thickness and with the individual cocci attached to each other. This subgroup is so named because in the microscope they appear like a bunch of grapes (the first portion of the term "staphylococci" means "grape bunch"). Most boils and abscesses are caused by staphylococci. (4) *Sarcina* are spheres arranged in a peculiar method, in cubes. They come to be grouped in cubes because of the fact that they divide in three planes in their multiplication process, one being a horizontal plane and the other two vertical planes at right angles. No important diseases of the human are produced by sarcina forms.

Multiplication.—As stated previously, bacteria multiply or reproduce by simple transverse division. When a given bacterium reaches a certain size and stage of maturity its cell membrane constricts about the middle of its body. The constriction continues until the organism is rended in two. The resulting two organisms may remain attached together or they may separate, depending upon the species involved. In either case, the two are independent cells thereafter. Under favorable conditions of food, temperature, moisture, etc., some bacteria divide as often as once in 30 minutes or even more frequently. Supposing all the progeny of such a single multiplying organism should live and reproduce every 30 minutes, calculate the number of individual bacteria there would be at the end of 24 hours. One investigator found that the cholera spirillum divided every 20 minutes, so long as favorable conditions prevailed. He calculated that in one day there would be 1 quadrillion 600 trillion of progeny from a single spirillum multiplying at such a rate. But probably no such rate of multiplication could be maintained even for 24 hours. Chemical products of the bacteria which are harmful to themselves, lack of available food, and other factors retard the rate of multiplication after a time.

Fig. 2.—*Bacillus tetani*, showing spores. Pure culture on agar. Fuchsin stain (Kolle and Wassermann). (From Jordan's "General Bacteriology," published by W. B. Saunders Co., Philadelphia.)

Spore Formation.—A few species of bacteria produce **spores.** An instance is the tetanus or lockjaw bacillus (Fig. 2). A spore is formed in the following manner: under certain unfavorable conditions of food, or of temperature, or oxygen supply, or of other factors, the living

matter or protoplasm of the bacterium's body is concentrated in a spherical mass. The mass is formed at either an end or near the middle of the bacillar body, the location of the mass depending on the species involved. In the case of the lockjaw bacillus, the mass is formed at one end, giving the organism a club-shaped appearance. Around the spherical mass formed as described above a relatively thick **spore wall** appears. (Fig. 3.) The spore wall gives the protoplasm within great resistance to unfavorable conditions in its environment. Within such a spore wall the organism may resist the heat of boiling water for an hour or longer and may resist drying for weeks or months. The wall is thus very impervious to heat or cold or to the exit of the moisture possessed by the protoplasm within. In the case of an anaerobic organism the spore wall protects from the free oxygen of the air. The spore is thus a state or condition assumed by the bacterium for protective purposes; it tides the organism over unfavorable periods of life. In this state the protoplasm is in almost dormant condition, quite inactive. When favorable conditions again return, the spore wall dissolves, by an enzyme or chemical substance which the body of the bacterium produces, the organism again assumes its bacillar shape, and resumes the *active* condition of life. Most organisms which form spores are bacilli. However, relatively very few species of bacilli form spores—fortunately for man, perhaps. When organisms produce spores, usually only one is formed in a single bacillus. Ordinarily spore formation is therefore not a means of multiplication.

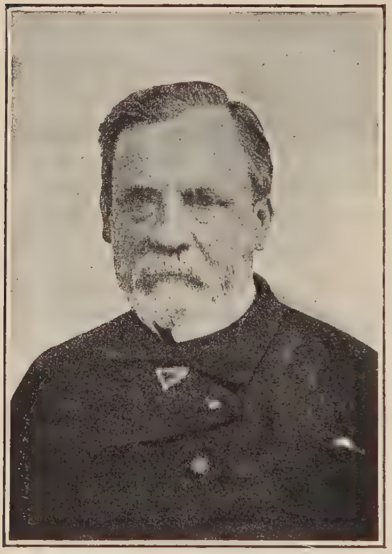


FIG. 3.—Louis Pasteur (from Peabody and Hunt). Many have named Pasteur as the greatest benefactor of the human race known to history. We may regard Pasteur as the founder of the science of bacteriology and the father of the germ theory of disease, but which is no longer a theory. He devised vaccines for prevention of anthrax in cattle and sheep, for preventing rabies or hydrophobia, and for chicken cholera. With his discoveries he was enabled to save two leading industries of France—the wine and the silk industries.

Toxins.—Some of the bacteria which parasitize man are known to produce poisonous substances in their bodies. The poisonous substances are known as **toxins.** Some kinds of toxin-forming bacteria

emit the toxins through their cell membranes into the surrounding medium. Toxins which are thus extruded through the body surfaces of the bacteria are termed **exotoxins** or **true** toxins. Among the most important of the exotoxins are those formed by the diphtheria and tetanus bacilli. Still other bacteria produce toxins which are not exuded through the body surfaces of the organisms but are retained in their bodies. Such toxins are spoken of as **endotoxins.** (What are the meanings of the Latin prefixes, *en-* and *ex-*?) Endotoxins are not released and free to produce their poisonous effects until after the bacteria die and their bodies disintegrate. The typhoid fever bacillus is one which produces an endotoxin. All toxins are comparatively easily

FIG. 4.

FIG. 5.

FIG. 4.—*Pleurococcus (Protococcus)*. Above, a single plant consisting of a wall, nucleus and four lobed parts of a body of chlorophyll. Below, plants in stages of division, those on the right having become entirely separated. Pleurococcus is a tiny plant found growing on shaded sides of trees, etc., in periods of prolonged rain. On the trees the Pleurococcus resembles green paint. (From Martin's "Botany with Agricultural Applications," published by John Wiley & Sons, Inc.; after Strasburger.)

FIG. 5.—*Oscillatoria*, a many-celled but tiny plant which is frequently found as a part of the green scums on ponds and pools. The cells are placed end to end and remain attached together. Magnified 540 times. (Reprinted by permission from Martin's "Botany with Agricultural Applications," published by John Wiley & Sons, Inc.)

destroyed by heat. Heating them at the water boiling point for 20 minutes destroys any of the toxins.

Antitoxins.—When an exotoxin, or true toxin, is introduced into the body of an animal or into the human body, the exotoxin stimulates the body cells or tissues to produce an **antitoxin.** (Consider the meaning of the prefix, *anti-*.) The antitoxin unites chemically with the toxin and thus a compound is formed which is harmless to the body. In this way the antitoxin neutralizes the action of its corresponding toxin. This neutralizing action is applied practically in the treatment of diph-

theria, for instance. The antitoxin is injected hypodermically into the patient. Then the antitoxin neutralizes the exotoxin which has been absorbed into the blood and tissues of the patient from the diphtheria bacilli living in the patient's throat. The exotoxin is thus rendered harmless to the patient. The introduction of an endotoxin into the animal or human body does not stimulate the production of antitoxins. Only true toxins or exotoxins stimulate the production of antitoxins. There are thus no antitoxins for endotoxins.

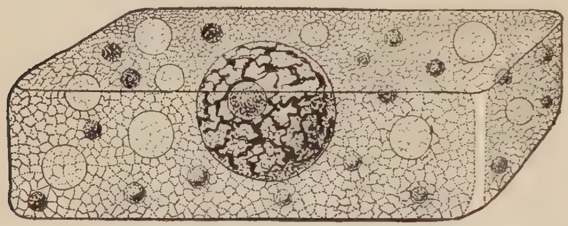


FIG. 6.—Diagram of a cell. The mass of the cell content consists of the protoplasmic network, with the coarser-grained nucleus. Within the protoplasm are more solid bodies, and droplets of more liquid substances. Note the cell has depth. (From Gruenberg's "Elementary Biology," Ginn and Co.)

Food-Poisoning.—The production of toxins by bacteria growing in foods frequently results in cases of poisoning. Such food-poisoning comes chiefly from eating meat and canned vegetables in which certain species of bacteria have grown. One of the organisms which sometimes causes food-poisoning is *Bacillus botulinus*. It is anaerobic and spore-forming. It lives in the soil, especially in the soil of our Pacific coast states. If foods are canned without heating to high degree under steam-pressure conditions, any botulinus spores which may be in the food will not be killed. After the can has been sealed and cooled the spores germinate and multiply in the anaerobic conditions present. The developing botulinus bacilli produce an *exotonin* which pervades the food. This toxin is the most powerful known; mere touching such intoxicated foods to the tongue has killed. Among the foods in which botulinus has been most found in this country are canned olives, canned spinach, and canned string beans. Home-canned foods are more often responsible for botulism than factory canned goods. Why?

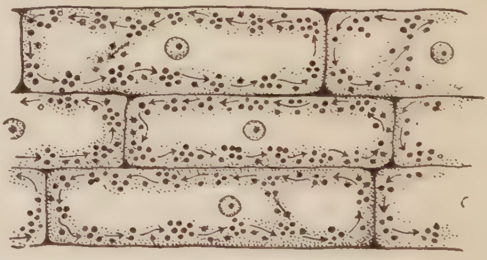


FIG. 7.—Protoplasm moves. The arrows indicate the streaming of the protoplasm within the cells of a plant. (From Gruenberg's "Biology and Human Life," Ginn and Co.)

But most cases of food-poisoning are due to a group of about three, four or five bacilli closely related to the typhoid bacillus and known as the *Gaertner group,* named for their discoverer. These organisms are aerobic and non-spore-forming. They produce endotoxins, which are not nearly so powerful as the botulinus toxin. They live normally in the intestines of a few persons, known as "carriers," and in the intestines of some of the lower animals, of mice, for instance. They thus reach foods through the feces of such persons or animals.

It should be repeated here that heating of foods to boiling point of water for 20 minutes destroys any toxin known. The interiors of masses of food should be heated so for 20 minutes. However, if there is reason for suspecting a can of food, it should first be heated and then discarded. Some of the food-poisoning bacteria produce no odor nor other evidence as basis for suspecting food.

"Ptomaine Poisoning."—Ptomaines are split products formed by the chemical splitting of protein substances by enzymes of bacteria living in the proteins. Ptomaines injected into the blood stream of animals are highly fatal. But ptomaines fed to animals in decomposed protein foods do not appear to be very poisonous. It is therefore believed that nearly all, perhaps all, cases of reported "ptomaine poisoning" are in fact food-poisoning due to toxins formed by bacteria growing in the food. Food-poisoning is thus a better term and should displace the older, inaccurate "ptomaine poisoning." It is now very certain that most all cases of so-called ptomaine poisoning are due to the endotoxins produced by members of the Gaertner group mentioned above. Tin poisoning of foods rarely or never occurs in recent years, for the tin of the can is not itself exposed. It is covered by a thin film of a metal which is never involved in the production of poisons.

Factors in the Growth and Multiplication of Bacteria.—There are several conditions of environment which are of importance to the life of bacteria. Among these factors are the following:

(1) *Moisture.*—Water is a necessity to all forms of living matter, bacteria being no exception. Water or fluid in which bacteria live serves as a vehicle for transportation of food and oxygen in solution to the organism. It also carries away waste products of the bacteria which might be of injury to themselves. Water is an essential also in the cell body for metabolism, for the physical and chemical processes occurring in the cell would not occur without presence of water. Some organisms succumb to drying in a few hours; others may live for weeks. Bacteria in the spore form, however, require but little moisture, being in a quiescent condition.

(2) *Temperature.*—Ranges of temperature in which bacteria live and thrive vary greatly with the different species. Each species has a more or less elastic range of temperature within which it grows. However, most bacteria pathogenic for man thrive best at or near the temperature of the human body, 37.5° C. or 98.6° F. Many disease-producing organisms are able to resist temperatures below freezing for days, weeks, or even months. The typhoid bacillus has been known to live several months in blocks of ice. On the other hand, most pathogenic organisms are killed by heating 10 minutes at boiling point of water or even at lower temperatures. Spores, however, may resist an hour of boiling.

Fig. 8.—Robert Koch, German scientist. Excepting Pasteur, Koch more than any other person was the founder of the science of bacteriology, which is so largely the basis of modern medicine and of hygiene and sanitation. Koch was the first to *prove*, by animal experiment, that a given disease was caused by a specific germ (1876). In 1882 he startled the world with the announcement that he had found the germ which causes tuberculosis.

(3) *Oxygen Relations.*—All living things must respire; that is, the intracellular respiration must occur. Oxygen is a necessity in bacteria for the oxidation of food in the cell body. Some bacteria require free oxygen of the air for respiratory purposes. They are called **aerobes.** Most bacteria are aerobes. But there are other bacteria which can not live in the *active* condition in the presence of free oxygen. For respiratory or oxidative purposes they utilize the oxygen which is freed in the assimilation of their food substances. This group of bacteria are termed **anaerobes.** (What is the meaning of the prefix, *an-*?) The tetanus bacillus is an example of the anaerobes; also the *Bacillus botulinus.* There are still other organisms which can live and thrive in either aerobic or anaerobic conditions. They are spoken of as **facultative** organisms.

(4) *Light.*—For most bacteria direct sunlight is a powerful germicide. It destroys the tubercle organism in 2 hours. Diffuse sunlight, such as that of a room, for instance, is less germicidal than direct sunlight. The growth of the typhoid bacillus is inhibited by one and one-

half hours' exposure to direct sunlight, but 5 hours of diffuse light are required to inhibit development. The violet and the ultra-violet are the most destructive of the sun's rays.

(5) *Bacterial Foods: Their Digestion, Absorption and Assimilation.*—Being living organisms, bacteria must have food for energy and growth. For energy production, they utilize carbon atoms split off the molecules of their foods by enzymes, which latter are produced by the bacterial bodies.

In the digestion of the various classes of organic foods they are converted from an insoluble state to a soluble condition. The foods must be rendered soluble so as to be absorbed through the cell membrane in solution in water, for this is the organism's method of receiving food. Some bacteria possess enzymes that split proteins only; others have enzymes that split carbohydrates only; while still others possess enzymes of both types. Some bacteria are able to decompose fats.

During the digestive and assimilative processes gases may appear as resulting split products. Carbon dioxide and hydrogen are the most common of these. Acids and alkalies also may be produced, which leads to the development of an acid or alkaline condition of the medium in which the bacteria are growing. The souring of milk, for instance, is an example of this kind of reaction. Bacteria in the milk split the lactose or milk sugar molecule into molecules of lactic acid, which latter gives the milk the sour taste. Parasitic bacteria in the human body utilize substances in the tissues, tissue fluids, and blood for foods.

(6) *Influence of Reaction of the Medium.*—The last of the several factors of environment affecting the life of bacteria which we care to consider is that of reaction (acidity or alkalinity) of the medium in which the bacteria grow. Most bacteria grow best in a neutral or slightly alkaline medium. They do not thrive in wide ranges of acidity or alkalinity. In fact, strong acids and strong alkalies are frequently used as germicides.

Distribution of Bacteria in Nature.—These organisms are widely distributed in nature. They are found in air, in soil, rivers, lakes, sea, mountain tops and arctic regions. However, it is undoubtedly true that most pathogenic bacteria live a much shorter period of time, and in smaller numbers, in nature than was formerly supposed. With the exception of a few notable examples—typhoid and tubercule bacilli, for instance—pathogenic bacteria can exist outside the human body for only comparatively short periods of time, some for only a few minutes.

Antiseptics and Disinfectants.—Certain chemical and physical agents are frequently used for either inhibiting or killing bacteria.

Antiseptics are those agents which merely injure the organisms sufficiently to inhibit the activity and multiplication of the bacteria, without actually killing those present. **Disinfectants** or **germicides** kill the organisms to which they are applied. Some chemicals are only antiseptic; some are antiseptic in weak solutions and germicidal in strong solutions. Among the commoner antispetics and disinfectants are: tincture of iodine, mercurochrome, carbolic acid, formalin, bichloride of mercury, hydrocyanic acid gas, sugar solutions, solution of common salt, sunlight, heat, and cold. Methods for using various antiseptics and disinfectants will be described as needed in succeeding pages of this book.

2. THE YEAST PLANTS

The second group of microorganisms to be considered as causes of infectious diseases in man are the yeasts (Fig. 9). These organisms, however, produce relatively few diseases in man, and will hardly be more than mentioned here. Most yeasts are non-pathogenic, as in the case of the bacteria. They are *one-celled plant* organisms. They are usually oval-shaped. Their having a *clearly defined nucleus* is one feature which distinguishes them from bacteria. Their usual method of reproduction by "*budding*" distinguishes them from all other groups of microorganisms. In the budding process, a portion of the nucleus of the mother cell separates itself and moves to one side of the yeast cell. The separated nucleus becomes a part of a "bud" constricted off from the end of the mother cell. The bud remains attached to the mother cell till a certain size and degree of maturity are reached when it separates from the original cell and leads an independent life. Yeasts are of great economic importance, in bread making and in alcoholic fermentation processes.

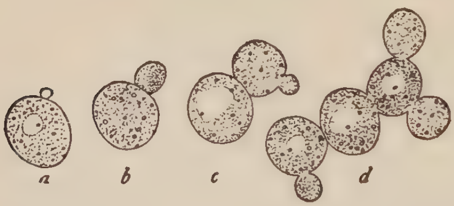


Fig. 9.—Growing yeast cells, showing method of budding and forming groups of cells. (From Conn's "Bacteria, Yeasts and Molds in the Home," Ginn and Co.)

3. THE MOLDS

A third group of microorganisms furnishing pathogenic members are the molds (Fig. 10). Molds are *multicellular* plants. They possess

fine, cottony, fiber-like bodies called the *mycelia.* Their chief method of multiplication is by means of **spores** which are produced on the ends of relatively long stalks. When the spores reach maturity they are disseminated by the wind or fluids or other agents and germinate when they come in contact with favorable environmental conditions. In germination, the spore produces a new mycelium. A commonly known mold which is not disease-producing is bread mold. A pathogenic mold which might be mentioned is that causing "ring-worm." The very fine microscopic mycelium of this pathogen grows in the tissues of the skin, thus producing the inflamed condition. Molds are causes of several diseases of the skin. The molds are of great economic importance, examples being the so-called rusts and smuts of corn, wheat, oats, and other cereals and of other plants of economic value.

FIG. 10.—A colony of *Mucor*, showing the mycelium and the sporangium of the fruit capsules. At *a* is a large sporangium filled with spores. (From Conn's "Bacteria, Yeasts, and Molds in the Home," Ginn and Co.)

4. THE PROTOZOA

Protozoa comprise one of the most important groups of causal agents of disease in man. Parasitic protozoa produce two of the greatest scourges of the human race—malaria and African sleeping sickness.

As the name indicates, protozoa are simple, *one-celled animal* organisms. They have *distinct nuclei.* Most are non-pathogenic. They live in fluids and water, at least while in the *active* condition. They are classified according to their special means of locomotion into four classes:

(1) **The Sarcodina** (or **Rhizopoda**) have locomotion by means of *pseudopodia.* Pseudopodia (meaning "false-feet") are small portions of the mass of living matter which are slowly projected outward from the general contour of the cell body. This projected portion or pseudopodium is attached to the substratum and the rest of its body is

drawn up to the position of the pseudopodium, that being its method of locomotion. The extending pseudopodium appears much as if it were a tiny plant root growing outward, which appearance suggested the name Rhizopoda (meaning, " root-foot "), that term being sometimes used as the name for this class of protozoa. A commonly studied example of the non-pathogenic members of this group is the **ameba** (Fig. 11); while a parasitic form is the ameba-like organism, **Entameba histolytica,** which causes amebic or tropical dysentery (" flux "). This disease is quite common in the Southern States and is frequently found in more northerly latitudes.

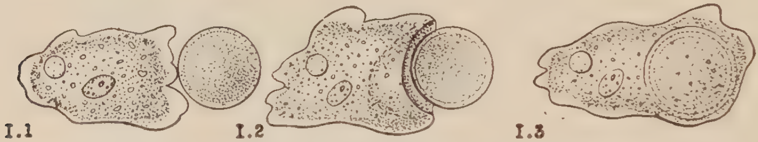


FIG. 11.—Feeding habits of *ameba*. The stages of the engulfing or ingestion of a tiny spherical plant are shown. (Modified from Curtis and Guthrie's "Textbook of General Zoology," published by John Wiley & Sons, Inc.)

(2) **The Infusoria.**—These have locomotion by the waving of fine, hair-like projections from their body surfaces. The projections are called **cilia.** This class is sometimes spoken of as the Ciliates. Why? The Infusoria (meaning, " to pour into ") have a mouth-like opening. Waving cilia around the " mouth " cause the water or fluid in which the organism is living to pass into the mouth, carrying food with it. The fluid appears to be pouring into the mouth, which suggested the name for this class. None of the common preventable diseases discussed in this text are caused by Infusoria. A non-parasitic infusorian is the Paramecium, which is quite common in streams, pools and other natural bodies of water.

(3) **The Mastigophora.**—The term Mastigophora means " whip-bearer." These organisms are more or less elongated and possess a long, whip-like projection at one end. The whip-like **flagellum** is waved strongly through the fluid in which the organism finds itself and thus furnishes the means of locomotion. The class frequently is called the flagellates. Why? A non-parasitic form is the Euglena, found in natural collections of water. Of the parasites of this class, we might name the Trypanosomes, which cause the dreaded African sleeping sickness and other important diseases in certain parts of the world. In the United States this class of parasites is not of great significance.

(4) **The Sporozoa.**—This class of protozoa possesses no special means of locomotion. The little locomotion they reveal is attained by mere

wriggling. All members of this class are parasitic, in man, animals or plants. Malaria is produced by Plasmodium, a member of this group.

5. THE SPIROCHAETES

Spirochaetes (meaning, " spiral hair ") possess a peculiar mixture of characteristics. Some of their characters, the lack of a definite nucleus, for instance, are those of bacteria; while others, like capacity for flexing and contracting, are those of protozoa. The spirochaetes, therefore, occupy a position midway between the plant group of bacteria on the one hand and the animal group of protozoa on the other. Strictly speaking, they appear to be neither wholly animal organisms nor wholly plant

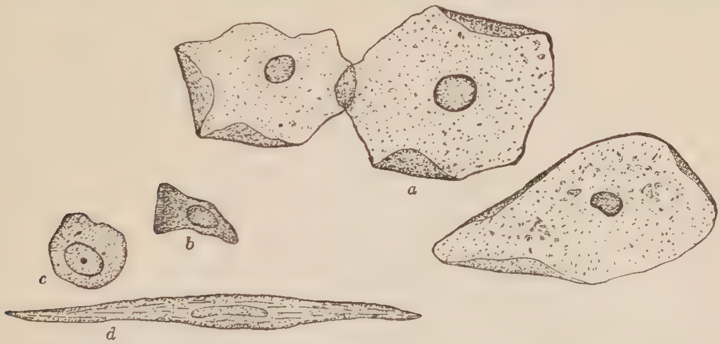


FIG. 12.—Various forms of cells in human body. *a*, squamous epithelium from the tongue; *b*, a columnar cell from the small intestine; *c*, a polyhedral or spheroidal cell from the liver; *d*, a smooth muscle cell from the muscular coat of the stomach. x 550. (From Jordan's "Text-Book of Histology," D. Appleton and Company, New York.)

organisms. With regard to form, they closely resemble spirilla. They appear to multiply by both transverse and longitudinal division. Certain spirochaetes are the causal agents of some of the most dreaded scourges of the human race, syphilis, Asiatic cholera, and probably yellow fever being among them.

6. THE WORMS

Two groups of worms should be mentioned as producing some of the chief affections of man. Those two groups are termed the **Flatworms** (**Cestodes**) and the **Roundworms** (**Nematodes**). Some of the worms are microscopic in size, whereas others are several inches or even several yards in length. Again, some are microscopic while in the infective stage of development, but easily seen by the unaided eye after maturity in man.

Of the Flatworms, the most important ones parasitic in man in the United States are the Tapeworms. The embryo of one of the species of tapeworms is found in the muscles of infested beef and reaches the human intestine by the eating of such infested beef without sufficient cooking to kill the embryo parasites. Other species of American tapeworms are gotten from infested pork and fish that have not been sufficiently cooked.

An example of the Roundworms is the notorious hookworm of our Southern States. Other Roundworms also parasitize the intestines of children accustomed to playing in infected soil.

CHAPTER II

DISEASES DISSEMINATED BY INTESTINAL DISCHARGES AND HOW TO AVOID THEM

THE communicable diseases whose "germs" are disseminated by the alvine discharges of patients and "carriers" include typhoid, the two paratyphoids, both amebic and bacillary dysentery, Asiatic cholera, and hookworm. Tetanus, or "lock-jaw," germ is disseminated by the dung of herbivorous animals, especially that of horses and cattle. Tetanus will be considered in another chapter.

These are the so-called "filth-borne" diseases. They are the result of filthy habits and practices, both personal and public. Typhoid cases are the consequence of the patients' having received into the mouth and digestive tract, more or less directly, a portion of bowel and urinary discharges, either by way of the fingers, contaminated water, or foods.

Preventive science has made remarkable progress during the past three or four decades toward the scientific conquest of this group of diseases. If present scientific knowledge of these diseases were put to practice in all communities, probably at least 90 per cent of these diseases now occurring would be prevented. To mention a specific instance of accomplishment by one community: Chicago has been making a special effort to reduce its typhoid rate since soon after the year 1890. The typhoid death rate in that city is now only about $\frac{1}{150}$ of what it was forty years ago. It might be added also that many communities in the United States have at present 20 times as much typhoid in proportion to population as does Chicago. Those communities have not applied scientific knowledge which is available to them. Familiarity with this disease has bred a remarkable indifference.

Typhoid is selected as the type study among this group of diseases and will be treated in a more extended manner than others. Some diseases will be omitted altogether from our consideration for various reasons. Notwithstanding this omission, more attention will be given to this particular group of diseases than to some other groups because of the fact that sanitary science has more to offer for prevention of this group than for the prevention of some others.

Since the only source of the germs which cause the diseases of this group (excepting tetanus), are the urine and feces of patients and carriers, it is obvious that the most fundamental measure for the prevention of these diseases is such disposal of the excreta as to insure safety.

TYPHOID FEVER

Causal Agent.—*Bacillus typhosus.*

Source of Causal Agent.—Bowel discharges and urine of patients and "carriers."

Exit of Causal Agent from the body of the patient or "carrier" is chiefly through the bowel discharges or feces. About one-third of infected persons harbor the bacilli in the bladder and thus discharge them through the urine as well as through the feces.

Entrance of Causal Agent into the body of the prospective patient is gained through the mouth with contaminated food, drink, or fingers. The bacilli may also gain entrance through the nose from contaminated fingers, and from the nose pass down into the back portion of the mouth.

Agents of Transmission are water, ice, milk, shell-fish, and other foods, house-flies, and contaminated fingers. Of course none of these agents are capable of transmitting the typhoid bacillus without first having become contaminated with excreta of a patient or carrier.

The Incubation Period of an infectious disease is the period intervening between the time when a patient receives infection and the time of development of the first symptoms of the disease. In the case of typhoid fever the incubation period is 7 to 23 days, averaging about 12 days.

Period of Communicability.—The patient begins to discharge typhoid bacilli at about the time of the appearance of first symptoms of the disease. He continues to discharge them throughout the course of his case. Many patients discharge the germs for many days or weeks after the disappearance of symptoms. Some continue to harbor and discharge the bacilli for years, or even during entire life. We may say, then, that the period of communicability of typhoid begins at about the time of the first appearance of symptoms and continues throughout the course of the case and on until repeated bacteriological examinations no longer show presence of typhoid bacilli in urine or feces.

Nature of the Disease.—The typhoid bacilli enter through the mouth, pass to near the lower end of the small intestine where they make their way into the tissues of the intestinal wall. In the intestinal wall the bacilli multiply in great numbers and many pass into the blood stream. Thus in the blood of all parts of the body there are many millions of the bacilli. In the wall of the intestine the bacilli cause ulcers

to be formed. In the ulcerated areas the walls of blood vessels may be eroded with resulting hemorrhage or loss of blood into the intestine. Or the erosion or decay of tissue may proceed so far as to produce a perforation of the intestinal wall. Through the perforation large numbers of bacteria may pass into the abdominal cavity surrounding the intestine and in this case death is likely to be produced by the growth of bacteria in the cavity, which diseased condition is known as *Peritonitis.*

Many of the bacilli in the intestinal ulcers and in the blood stream die, being killed by substances produced by the body cells to resist the bacilli. Their disintegrating bodies release toxins or poisons which produce the fever attendant. These conditions lead to great prostration and emaciation.

Measures for Prevention.—Measures for prevention of any disease depend on four factors: Source of the causal agent, route of exit of the causal agent from the body of the patient, route of entrance of the causal agent to the body of the patient-to-be, and the agents of transmission. If one knows these four factors in the dissemination of a given disease, he can then formulate the measures of prevention or of control. Measures for prevention and control of typhoid are determined by these same four factors. The four factors involved in dissemination lead logically to measures of control and prevention.

(*a*) *Measures Concerning the Patient and His Environment:* (1) The typhoid patient should be isolated, in a modified degree, in a fly-proof room, and any house-flies found in his room should be killed promptly. (2) Members of the household and nurses should receive typhoid vaccine. (3) Concurrent disinfection is of the utmost importance. That is, the bowel and urinary discharges of the patient should be disinfected, after the manner to be described later, even though an efficient sewer system and sewage disposal plant service are had. Articles of clothing, and bedding of the patient, eating utensils, and fragments of lunch which might have been contaminated by the patient's hands, also must be disinfected. The nurse's hands should be disinfected immediately after handling the patient or after touching his bedding or eating utensils. (4) Terminal disinfection is that which is made at the termination of the case. It might be well first to go over the furniture and floor of the patient's room with cloth saturated with a strong solution of a disinfectant, then scrub the furniture and floor with soap and warm water.

(*b*) *Public Measures of Prevention:* (1) Of utmost concern to any community should be the purification of its public water supply. Safe water for tourists and tourist camps is a need which has arisen recently, and such water supplies should be subject to the approval of state health

departments. (2) Of equal importance with purification of water is the necessity of cleanly produced milk and efficiently pasteurized public milk supplies. (3) Supervision of food supplies, with special attention for those to be consumed without cooking, to see that they are handled in a sanitary manner and that no patient or known carrier handles such foods. (4) Prevention of fly breeeding by disposal of animal manure in carefully screened bins. Or chemicals may be spread upon the manure to prevent the development of fly larvae. (5) Sanitary disposal of human excreta by approved individual home methods or by public sewage treatment plants, which are to be described later. Toilets of tourist camps should meet approval of state health departments. (6) Universal typhoid vaccinations, especially in communities where the fever prevails. (7) Vaccination of vacation travelers.

Methods of Concurrent Disinfection.—Concurrent disinfection is "the application of disinfection immediately after the discharge of infectious material from the body of an infected person, or after the soiling of articles with such infectious discharges, all personal contacts with such discharges or articles being prevented prior to their disinfection." As methods of concurrent disinfection in connection with typhoid cases the following may be used: Have a druggist prepare two or three gallons of 5 per cent solution of carbolic acid. The hands of the nurses may be washed in this solution diluted with an equal amount of water. Their hands must be sterilized in this manner before going to the ice box, dining room, or kitchen. Stools of the patient should be deposited in a glass or earthen vessel containing a volume of the undiluted 5 per cent solution that is twice the volume of the excreta. The stools must remain at least two hours in the solution. Large or hard masses of feces must be crushed to allow penetration of the disinfectant. The patient's urine is evacuated into a vessel containing an equal amount of the carbolic acid solution. Bath water and thermometer also are to be sterilized in the 5 per cent carbolic solution. Instead of the carbolic acid solution a 1 : 1000 aqueous solution of bichloride of mercury, or a 10 per cent solution of formalin may be used for the purposes mentioned above. Bed linens, handkerchiefs, towels, clothing and eating utensils may be boiled in water for 20 minutes to disinfect. A 1 per cent or 2 per cent solution of lysol is an excellent disinfectant.

Methods of Terminal Disinfection.—Disinfection of the room and furniture at the termination of the case is known as **terminal disinfection.** Health officers no longer **fumigate** the room with burning sulphur or formaldehyde lamps, etc., for the purpose of killing germs that remain after the disease. Such fumigation is used only to kill insects or vermin.

In terminal disinfection, the wall paper may be torn down, or the wall, if not papered, may be mopped with a 10 per cent solution of formaldehyde or 1 per cent lysol. The floor is mopped with the same solution, after which the floor is scrubbed with soap and water, then aired and dried. The furniture likewise is wiped with a cloth moist with formaldehyde solution, then washed with soap and water. Mattresses may be exposed on both sides to the direct sun for a day or two.

The formaldehyde solution purchased at drug stores is a 40 per cent solution. To make it a 10 per cent solution add 3 times its volume of water.

Instead of the formaldehyde solution a 1 : 1000 solution of bichloride of mercury may be made by mixing 1 ounce of the chemical with 10 gallons of water. The bichloride of mercury solution is extremely poisonous and should be kept from children and animals.

Typhoid Vaccine.—In the preparation of typhoid vaccine, typhoid bacilli are put into salt water of a density similar to that of the body fluids. This *suspension* of bacilli is then heated at 56° C. for 30 minutes, which kills the organisms. The number of killed bacilli in a selected quantity of the salt solution is then estimated, by methods which need not be described here. The salt solution with the suspended typhoid bacilli constitutes the vaccine. To immunize a person against typhoid three doses of the vaccine are injected hypodermically at intervals of one week. One-half billion of the suspended killed organisms are injected as the first dose or "shot." One billion are given in each of the two remaining injections.

Immunity Conferred by Vaccination.—It is thought that the immunity acquired as a result of typhoid vaccination requires about six weeks to two months to develop. How immunity is produced by the vaccine is not definitely known, but it is thought that, as the bodies of the dead bacilli disintegrate within the human body, bacterial proteins are released into the tissues of the human body. It is further believed that these bacterial proteins stimulate the tissues of the human body to produce anti-substances, and that the anti-substances are antagonistic to living typhoid bacilli which might in the future gain entrance to the body, or are antagonistic to their toxic products.

It is generally believed that the immunity lasts for at least two or three years. The United States army re-inoculates the soldiers every three years, which might be a good practice for civilians until three immunizations have been had. Even though one has been carefully immunized it is conceivable that he might receive a sufficiently massive dose of typhoid bacilli from heavily contaminated milk or water, for instance,

that the resisting substances built up in his body by the vaccine would be overtaxed and typhoid would result. In fact, it is believed that such cases have been noted. Regardless of one's feeling of assurance that he

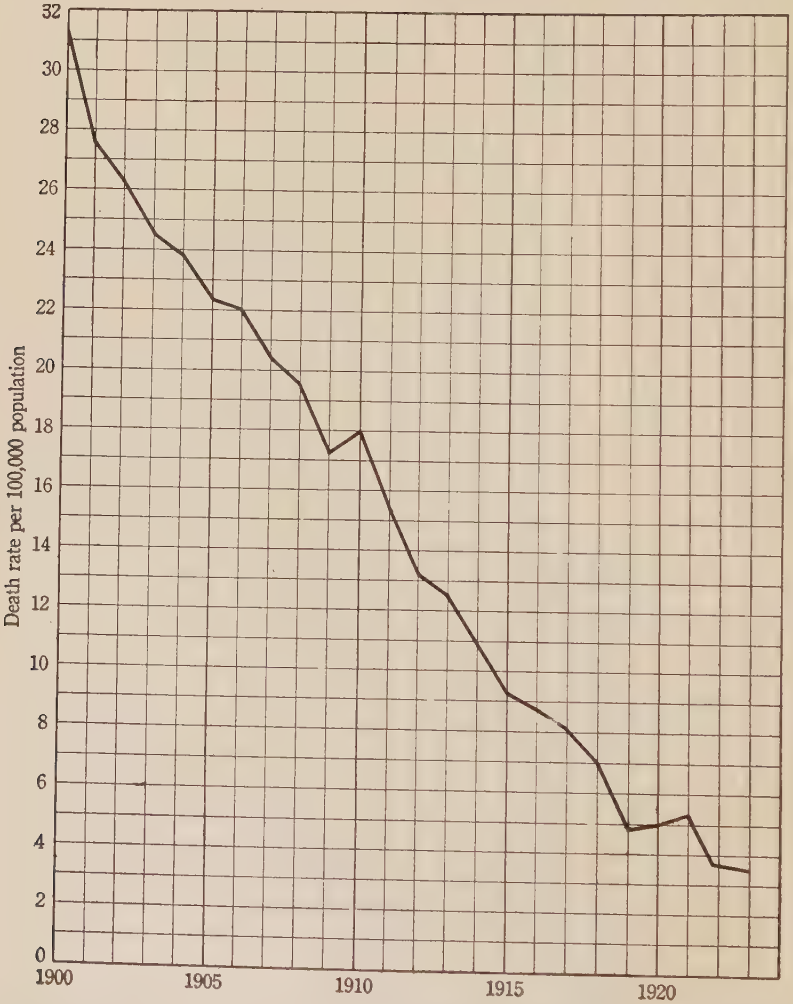


FIG. 13.—Death Rate from Typhoid Fever per 100,000 Population in the United States' Registration States of 1900. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton and Co.)

is thoroughly immune, all precautions against infection should be taken. Assurance of immunity should not encourage carelessness or a feeling of absolute security. In this connection it might be stated that when a

person has once had typhoid fever itself, immunity is usually conferred for the rest of life.

Efficiency of the Vaccine.—Scores of instances might be cited to illustrate the efficiency of the vaccine in preventing typhoid. Among nurses in Massachusetts during a three-year period typhoid was nine times as prevalent among those who had not been vaccinated as among those who had received the vaccine.

In the summer of 1911 there were 12,081 United States soldiers stationed at San Antonio, Texas. Compulsory typhoid vaccination prevailed in the army. During that period there were 49 cases of typhoid in the city of San Antonio, the town having a population of 60,000 at that time. The soldiers had free access to the city, but only 2 developed typhoid. One of them had received only two doses of his immunization and had a very mild case of the fever. The other had never had any part of his vaccination.

The experience at San Antonio was in marked contrast to an experience at Jacksonville, Florida, during the Spanish-American War, prior to the practice of typhoid inoculation in the United States army. Stationed at Jacksonville was about the same number of men as were at San Antonio. And they lived under practically the same conditions of life. But at Jacksonville were 2693 cases of typhoid.

During the recent World War all American soldiers were inoculated for typhoid. There was one death from typhoid to each 25,000 soldiers enlisted. During the Spanish-American War, no typhoid inoculation obtaining in the army at that time, there was one typhoid death to every 71 soldiers.

The remarkable results with typhoid inoculation reported from the army were no doubt in part due to sanitary precautions taken. For instance, during the Spanish-American War the sanitary regulations of the army were not nearly so rigid as those prevailing in the army of the World War. What proportion of the credit should be assigned to sanitary measures for these surprising results, no one, of course, can say, but it is very certain that a great part of the credit should be given to the universal typhoid vaccination which prevails in the army.

At any rate, our army of the World War demonstrated to us, even under the unfavorable conditions of war, that inoculation plus sanitary measures can almost eliminate typhoid from existence.

Typhoid "Carriers."—A carrier is a person who harbors and disseminates the germs of any given communicable disease, without himself showing symptoms of that disease. Typhoid bacilli from a carrier may produce disease as readily as those from a patient. Typhoid carriers

probably constitute the largest obstacle in the complete eradication of the disease. They discharge the typhoid bacilli constantly or intermittently with either feces or urine, or both, and there is no practical method of curing these menaces of public health. In February, 1928, the New York State Health Department reported that 208 carriers had been located in that state, exclusive of New York City. In New York City nearly 300 have been discovered. These carriers are known to have given rise to many cases of the fever. It is said that in Alabama 5 per cent or more of the population are typhoid carriers. Some 10 per cent of recovered typhoid patients in Alabama have been shown to remain carriers. Recovered typhoid patients may remain carriers for a few weeks only, or for a few months or years. Some remain carriers during the rest of life. Carriers who are careless of personal habits of hygiene are perpetual menaces to neighbors, especially when such carriers have a part in preparation and serving of foods; for, it has been found that more than 8 per cent of waiters and waitresses in restaurants have fecal discharges on their fingers in the morning hours from 8:00 to 10:00 o'clock.

The most famous of carriers reported was "Typhoid Mary." This woman cooked for several families successively in New York City, and was responsible for the infection of 26 members of those families during a period of 5 years. She was taken to a hospital, but later was released on promise not to cook or serve foods. She broke promise, obtaining employment as cook in a hospital in another part of the city. There she became responsible for a typhoid epidemic, 25 doctors, nurses, and employees contracting the disease from her. Another carrier epidemic followed a church dinner recently in a small town in Michigan. Two weeks following the dinner 33 cases of typhoid developed among the participants. It was found that all the patients had eaten squash. The squash had been prepared by an aged woman and contributed to the dinner. Bacteriological examination showed the woman to be a carrier. At Norman, Oklahoma, recently there occurred a paratyphoid epidemic of about 40 cases, a number of students of the University of Oklahoma being among the patients. A paratyphoid carrier had contaminated milk at a dairy. Later investigation revealed the fact that this same itinerant dairy worker had previously caused an outbreak of paratyphoid from a dairy at Oklahoma City. Many other epidemics similar to those mentioned above have been traced in recent years to typhoid carriers as sources.

Incidence and Prevalence of Typhoid.—Typhoid is prevalent in all parts of the world, in tropical and arctic regions, in the lowlands

and on the mountains. In our country the higher typhoid sickness and death rates are in the Southern States, due perhaps to a longer and hotter summer in addition to slower development of sanitation in those states. Sanitary measures in this country have developed far less in rural sections than in large cities, and the Southern States are distinctly rural.

SOME OF THE CAUSES OF DEATH

(Compiled from the U. S. Census)

Cause of Death	Death Rate per 100,000 Population				Number of Deaths, 1926
	1900	1910	1920	1926	
Typhoid and paratyphoid fever	35.9	23.5	7.8	6.5	6,826
Malaria	7.9	2.2	3.6	1.9	2,006
Smallpox	1.9	0.4	0.6	0.4	377
Measles	12.5	12.3	8.8	8.2	8,607
Scarlet fever	10.2	11.6	4.6	2.5	2,662
Whooping cough	12.1	11.4	12.5	8.9	9,317
Diphtheria	43.3	21.4	15.3	7.5	7,836
Influenza and pneumonia	181.5	115.1	153.7	143.2	150,606
Meningococcus meningitis	......	0.4	1.6	1.3	1,413
Tuberculosis of the lungs	181.8	139.7	100.8	76.4	80,375
Tuberculosis, other forms	20.1	20.6	13.4	10.6	11,193
Cancer	63.0	76.2	83.4	94.9	99,833
Diabetes (mellitus)	9.7	14.9	16.1	18.0	18,881
Diseases of arteries (apoplexy, etc.)	75.5	79.4	86.4	108.9	114,530
Diseases of the heart	132.1	158.8	159.3	199.1	209,370
Bronchitis and broncho-pneumonia	67.6	70.5	67.9		
Diarrhea and enteritis	133.2	117.4	54.4	33.6	35,296
Bright's disease (kidney)	89.0	99.1	89.4	98.3	103,332
Homicide	2.1	5.9	7.1	8.8	9,210
Suicide	11.5	16.0	10.2	12.8	13,410
Automobile accidents	......	1.8	10.4	17.9	18,871
Death rate, all causes (Some are not included above)	1755.0	1496.2	1306.0	1222.7	

Study the typhoid death rate in table above.
What other diseases are on decided decline?
What ones are on a decided increase?
What ones show no material change?

But why should typhoid occur most in late summer and autumn and more in warm countries than in temperate? This question can not be

answered definitely. Three probable factors might be suggested: (1) the increasing number of house-flies as the summer progresses; (2) the devitalizing effect of warm summer days with consequent lowering of the body's capacity to resist the typhoid germ; and (3) the greater amount of travel in the summer months resulting in more opportunity for contracting the typhoid bacillus.

Economic Cost of Typhoid.—Typhoid occurs most among the young. Its highest fatality is in the age period of 15 to 25 years, at just the period when individuals are beginning their life work. The consequent economic loss to the nation is enormous. The National Conservation Commission estimated that the economic value of each life taken by typhoid was $5000. With this estimate as the basis, the economic loss from typhoid deaths in the United States in 1926 amounted to $37,500,000. Furthermore, in 1926 there were about 100,000 cases in this country that recovered. In Oklahoma there were 504 typhoid deaths in 1927, and a total of about 7000 cases. The deaths alone represent an economic loss to the state of $2,500,000. Assuming that the average Oklahoma typhoid patient was an earner of $2.00 per day, and that he lost 50 days from work because of his illness, a total loss of $700,000 to the state is calculated. The total economic loss to Oklahoma from both typhoid deaths and typhoid cases amounted to almost $3,000,000 in 1927. However, there are states, especially in the South, where the typhoid rates are higher, it is believed, than those of Oklahoma.

Typhoid a Small-town Disease.—Until a few years ago, the cities were the hotbeds of typhoid. But during the last several years the larger cities especially have made remarkable progress toward the total eradication of this disease. This progress has come chiefly as a result of three lines of sanitary effort: (1) Safe disposal of human excreta by means of extensive sewerage systems and sewage disposal plants; (2) purification of city water supplies, mostly by means of sand filtration and chlorination of the water; and (3) pasteurization of city milk supplies. By those methods 57 of the larger cities of the United States have reduced their average typhoid death rates from 19.59 per 100,000 population in the year 1910, to 3.07 per 100,000 population in 1924.

There were seven cities of more than 100,000 population each which in 1927 did not experience a single typhoid death, a great contrast to the condition prevailing in those cities a few years ago.

Note in the table below the rate of decline of typhoid in certain cities of the United States.

Typhoid Death Rates per 100,000 Population

	1906–10	1911–15	1916–20	1921–25	1926	1927
Chicago	15.8	8.2	2.4	1.4	0.8	0.7
New York City	13.5	8.0	3.2	2.6	1.9	1.3
New Haven	30.8	18.2	6.8	4.4	2.2	0.0
New Orleans	35.6	20.9	17.5	11.6	18.6	8.0
San Francisco	27.3	13.6	4.6	2.8	2.5	1.7
St. Louis	14.7	12.1	6.5	3.9	2.3	1.9
Denver	37.5	12.0	5.8	5.1	3.5	2.8
Nashville	61.2	40.2	20.7	17.8	35.0	16.0
Dallas	....	....	17.2	11.2	8.9	6.6

The small towns and rural districts have made little or no progress in the eradication of typhoid. Their sanitary progress and typhoid rates have remained on a level. Formerly their typhoid rates were considerably lower than those of cities, but now they are much higher, due to the rapid reduction of rates in cities. A recent investigation of typhoid incidence in Alabama revealed typhoid rates for communities of varying sizes as follows:

	Annual Typhoid Death Rate per 100,000 Population
Unincorporated Villages and Rural Districts	5.2
Towns of 500 to 1,000 population	44.3
Towns of 1,000 to 2,500 population	30.7
Towns of 2,500 to 5,000 population	18.6
Towns of 5,000 to 10,000 population	16.5
Towns of 10,000 to 25,000 population	11.8
Towns of 25,000 and over	6.3

Make a list of the factors which you think might aid in explaining the higher typhoid rate in the towns of 500 to 2,500 than in the rural districts and villages. Make a similar list of the factors which account for the higher typhoid rate in the towns of 500 to 2,500 population than in the cities of over 25,000 population.

Fly-borne Typhoid.—Perhaps the part played by the house-fly in the dissemination of typhoid has been exaggerated to some degree by zealots. The statement that flies cost 70,000 to 100,000 lives annually in the United States is probably itself an exaggeration. Yet it is very certain that the house-fly can carry typhoid bacilli in masses of contaminated feces on its hairy feet for at least several hours under average con-

ditions before the bacilli have dried sufficiently to die. It has also been shown by experiment that typhoid bacilli lapped up by a fly may be excreted living from the fly's intestinal tract for as long as 23 days. During a typhoid epidemic 5 out of 18 flies captured in the vicinity of privies were found to be vectors of typhoid bacilli.

The house-fly probably plays only a small part in dissemination of typhoid in well-sewered cities. Its greatest focus of activity as typhoid vector is probably in the small unsewered town where there is an open privy in each back yard only a few steps removed from kitchens and dining rooms. In such towns where the typhoid rate is high, it is very convenient for the house-fly to contaminate himself with typhoid germs in the fecal discharges of a carrier or in those of a patient when improper disposal is made of the patient's excreta, as is frequently done. Such flies may reach the dining room or kitchen and contaminate food with typhoid organisms even though such houses may be well screened. Investigation has shown that typhoid bacilli may live long periods of time in a moist fecal mass and multiply rapidly.

To prevent fly-borne typhoid, the breeding of house-flies must be prevented. Flies should be killed or trapped from the earliest part of the season. The importance of this may be realized from the following: each female fly lays 100 to 200 eggs at a time. It requires the eggs 10 days to become adult flies. Some one has taken the trouble to calculate that a single female fly from May 1 to October 1 may become responsible for progeny in the following numbers: 1,096,181,249,310,720,000,000,000,000. This is assuming that all the eggs would hatch and all the flies would live without meeting accident, which assumption is, of course, illogical.

To prevent breeding of flies, animal manure should be disposed of in bins which are carefully screened. Or, chemicals may be spread upon such manure so as to prevent the development of fly larvae. Stables and residences, of course, should be screened. The use of fly-traps is, of course, a secondary measure, but they frequently are quite useful and should be kept about the doors of the country home, for instance.

Water-borne Epidemics of Typhoid.—It should be understood at the outset that typhoid bacilli do not multiply in water. Food for the organisms and other factors necessary for multiplication are absent or present in deficient quantities. Yet, the germs of typhoid can live in water for weeks or even a few months, especially in water of low temperature, for low temperatures appear to retard the metabolism of the organisms, reduce their rate of energy expenditure, and thus prolong and preserve their lives. Perhaps this partly accounts for the fact that fre-

quently the bacterial content of rivers in winter is found to be higher than that of the same rivers in summer.

Water-borne typhoid epidemics break out suddenly. How do you account for the suddenness of the outbreak of a water-borne epidemic of typhoid in a town? Frequently the outbreak of typhoid is preceded by an outbreak of dysentery or gastro-intestinal disturbances. What is the period of incubation of bacillary dysentery as compared with that of typhoid? Most water-borne epidemics occur in autumn, winter, or early spring when the water is cold.

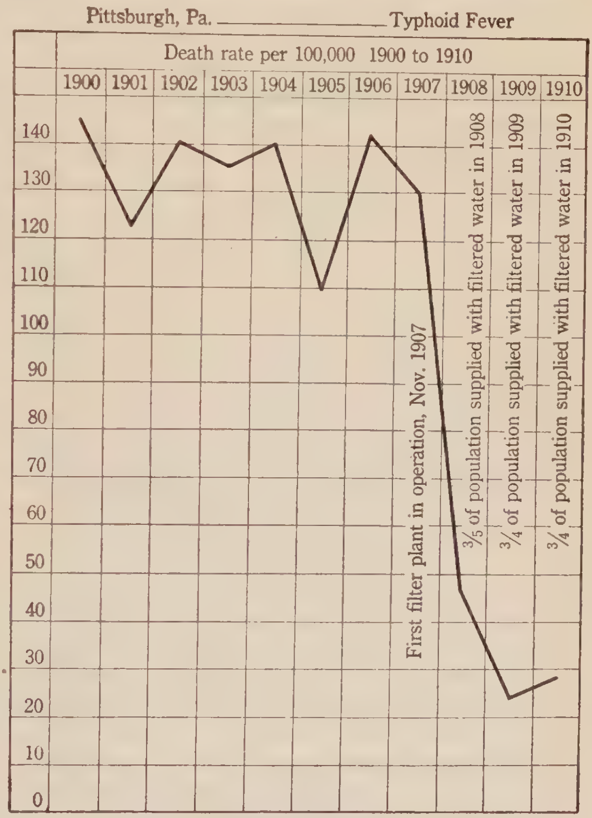


Fig. 14.—Immediate and Striking Effect of Purifying a Badly Infected Water Supply upon the Typhoid Situation. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton and Co.)

A few examples recounted may serve to illustrate the various ways in which water may become accidentally polluted with typhoid-laden human excreta. At Salem, Ohio, in recent years occurred an epidemic of several hundred cases, due to the contamination of the water in a main broken at a point near a broken sewer. A small village in Tennessee secured most of its water from two springs. A typhoid outbreak occurred in the village. Investigation showed that all the typhoid cases were in families using water from one of the springs. Heavy rains had washed typhoid-laden excreta from some privies into the spring. An epidemic at Ithaca, New York, also was traced to contamination of

water supply from privies. For many years Chicago ran its sewage into Lake Michigan some two or three miles from the point where water was pumped from the lake for domestic use. Chicago had a very high typhoid rate till the sewage was turned from the lake. A number of typhoid epidemics have occurred in various cities because of inefficient operation of water-purification plants, which are to be described later.

Milk-borne Typhoid Epidemics.—During the year 1926 there were 54 typhoid outbreaks in the United States and Canada due to milk which had been contaminated with typhoid organisms. In the spring and summer of 1927, Montreal experienced one of the greatest epidemics of typhoid in modern times, including altogether some 5,000 cases of the disease and several hundred deaths. The Montreal epidemic was due to infected milk. The milk was claimed by a pasteurizing company to have been pasteurized but an investigation conducted by the U. S. Public Health Service, with permission of Canadian authorities, showed that a large proportion of the milk passing through the pasteurizing plant was not pasteurized.

Milk may become infected if polluted water is used in the milk house for rinsing vessels and utensils. Or a carrier or patient of typhoid who handles the milk may infect it with hands that are contaminated with feces. A person who is nursing a case may infect milk with unclean hands. Without doubt, milk is one of the most important vehicles in transmission of typhoid bacilli.

Pasteurization of Milk is an absolute preventive against milk-borne typhoid, provided the pasteurizing is done efficiently. In pasteurizing, milk is heated to 142° or 145° F. for a period of 30 minutes. Heating to this degree kills all typhoid germs, as well as all other pathogenic organisms. In the home, milk may be pasteurized in a double boiler. Also, there are small pasteurizing outfits suited to family use and sold for three or four dollars by hardware houses.

Shellfish-borne Epidemics.—Occasionally shellfish become vehicles for transmission of the bacilli of typhoid. In the latter part of 1924, typhoid outbreaks were started in Chicago, New York City, Washington, Detroit, and other cities by oysters infected with typhoid germs. There were 165 cases in Chicago and about 600 in New York City. The oysters were found to have been grown on the shore of Long Island and near the outlets of sewers which emptied into the ocean. The patients had eaten raw oysters from this source. Professor Jordan and others have shown by experiment that the typhoid bacillus may live for 3 or 4 weeks in oysters. Even infected oysters definitely known to be thor-

oughly cooked entirely through the body probably would hold no danger. It is a safer practice to eat only cooked oysters, thoroughly cooked.

WATER SUPPLIES AND HOW THEY ARE MADE SAFE

Since contaminated water bears no special relation to any group of diseases except the group disseminated by intestinal discharges, it is altogether proper that we consider water and its relation to health at this point. Typhoid is the chief of the infectious diseases of this country to which water is related as a vehicle for the causal agent

Sources of Water Supplies for Cities.—Some cities take their water supplies from lakes, Chicago, for example. Others construct great reservoirs or artificial lakes. New York City has large reservoirs among the Catskill Mountains. Deep wells serve as water supplies for some small cities. Such wells, if properly constructed, make one of the safest sources of supply. The author made bacteriological tests of water from wells of 3,000 feet depth at Waxahachie, Texas, and found the number of bacteria wholly negligible, there being only 4 or 5 per cubic centimeter of water. Large springs serve as supplies for some favorably located towns, Johnson City, among the mountains of East Tennessee, being an example. Many cities obtain water from streams, St. Louis and Cincinnati, for example. Water supplies taken from streams are likely to be the most polluted and more imperatively to demand careful methods of purification, as those streams may be polluted by towns upstream or by single dwellings, or by campers or hunters and fishermen. Such pollution, once in the stream, is carried for long distances by the movement of the water. Professor Jordan found that sewage bacteria were carried as far as 150 miles down the Illinois River. The swifter the stream, the further the excreta and bacteria would be carried.

Water-Purification Methods.—Water-purification is for the purpose of preventing diseases the germs of which are distributed by the alvine discharges. All the important diseases contracted from water belong to this class. Hence it is proper that we should here consider methods or purifying the water supplies.

(1) *For Cities.*—The most popular methods of purifying water for cities is passage of the water through a **rapid sand (mechanical) filter,** then **chlorinating** the water. The rapid sand filter consists of a bed or beds of sand, not large, with sand about 30 inches in depth. The water is allowed to filter down through the sand, which removes most of the sediment and about 90 per cent of the bacteria. After filtration, chlorine

FIG. 15.—A protected well. It is impossible to "prime" this well and it is protected with concrete. (From Kibbey's "Principles of Sanitation," F. A. Davis Co.)

is run into the mains as the water leaves the filtration plant for the storage reservoir. Just sufficient chlorine is used to kill the remaining bacteria of the water. The chlorine produces an unpleasant taste in the water but is harmless to health. Sand filtration and chlorination are of great aid in the effort to eradicate typhoid fever. Both are comparatively new processes. During the last fifteen years as a result of the use of the filter and chlorinator, the average typhoid death rate in the leading cities of the United States has declined from 30 per 100,000 population

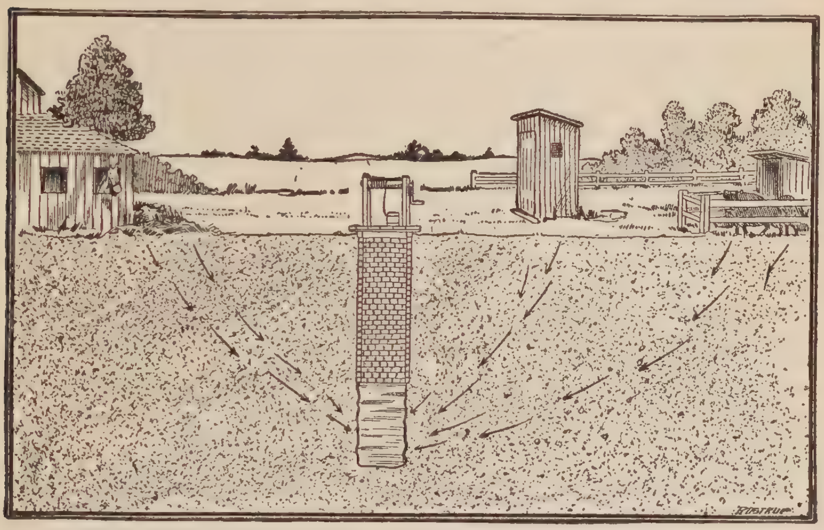


Fig. 16.—Popular idea of how wells become infected from surface pollution. This probably rarely takes place in rural districts, as the soil can usually hold back most of the impurities. The danger is great, however, where fissures, cracks or crevices exist, or where sewage enters beneath the surface of the soil from broken drains or leaky privies, especially in limestone formations. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton and Co., New York.)

to 3 per 100,000. It is believed that because of these two processes 200,000 persons are living today who otherwise would not be.

(2)· *For Country Homes, Camps, etc.*—For a safe water supply for the country home, an excellent provision is a drilled well one hundred or more feet in depth and properly cased in with iron casing for the entire depth. Even a well of such construction should be on an elevation with reference to the dwelling and out-houses and should be some distance from such buildings. If the well is to be a dug one, consideration should be given to the type of substratum. Some rock substrata have seams or crevices in the rock through which water may flow from the surface of

the ground without first having been filtered through the soil, but, with the average type of substratum, we may say that a dug well should be at least 30 feet deep. It should be walled in waterproof to near the bottom, so that water entering below the wall must be filtered through the soil, in passing from the surface of the earth down. The wall should extend well above the surface of the ground and should be covered with concrete. A pump should be installed. Pumps should not be " primed." Why? They should be repaired instead. The concrete top must be waterproof so that there is no chance for water which might have become contaminated with hands or shoes to return to the well. With the newer knowledge of how disease is transmitted has come a decline of respect for some revered institutions, the open well and bucket among them.

Springs are frequently sources of water for the country home. The water of springs passes through the earth in crevices of the rock or substratum and there is a possibility that the water has come down from the surface of the ground through such crevices without filtration through soil. Many springs may be thus contaminated. If a spring is used for domestic water supply, it should be walled in waterproof, covered with concrete, and a pump installed.

Cisterns usually are very dirty, from dust, decaying leaves, droppings of birds, and even decaying bodies of birds or mice which are frequently found in roof gutters. These sources of filth contain no typhoid bacilli, probably, but they are nevertheless unpleasant to consider. Filters, through which the water is made to pass before entering the cistern, are useless because never cared for properly.

Small filters of various types are used in some homes for filtering water. Such filters are generally useless, because of lack of care. Yet the family is afforded a false sense of security.

If water is suspected of being dangerous, it may be boiled 10 minutes and drunk with all security. Or, vials of calcium hypochlorite tablets may be purchased at drug stores. The vials contain directions for adding the tablets to water for the purpose of sterilizing. The water then may be drunk with safety. Or, again, two drops (no more) of tincture of iodine may be added to a quart of water and the water allowed to stand an hour before drinking; but this method is not preferred.

SAFE METHODS OF SEWAGE DISPOSAL

Disposal of human excreta bears a special relationship to certain animal parasites which inhabit the intestinal tract of man, such as the intestinal worms. But the chief relationship of sewage disposal in our

country is that which it bears with the group of diseases under discussion in this chapter. Hence it is proper and fit that we should here give consideration to methods of making a safe disposal of human excreta. Typhoid is the most important disease concerned.

Sewage Disposal for Cities.—It is the purpose here to describe only the more popular approved methods of sewage disposal for municipalities. There are two chief aims in the matter of sewage disposal: To render the sewage non-putrescible and to reduce numbers of bacteria as much as possible. Such methods fall into three general classes: (1) Those methods which depend upon **anaerobic** bacteria to produce such chemical changes in the organic matter of the sewage as to make the organic matter stable and non-putrefying, and to destroy or remove the maximum number of bacteria from the sewage. (2) Those methods which utilize **aerobic** bacteria to produce the two same general results sought and mentioned above. We may term the former *anaerobic* and the latter *aerobic* methods. (3) **Chemical** methods in which chemicals are used to destroy bacteria which remain after the sewage has been treated by one of the two methods named above. Chemical methods are rarely used alone in treatment of sewage of municipalities. We shall consider each of the three methods singly and in order named above.

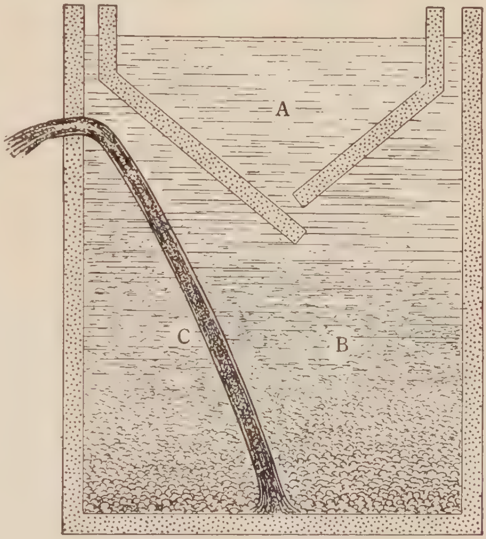


FIG. 17.—Cross-section view of an Imhoff Tank. *A*, chamber for the flowing sewage. The sewage may be thought of as flowing very slowly away from the reader toward the farther end of the tank. *B*. Anaerobic digestion chamber. As the sewage flows slowly through (*A*) the solid matter drops into compartment (B). There most of it is converted into fluids and gases by the anaerobic bacteria. Follow the course of the gas bubbles as they rise through the fluid. *C*. Pipe for withdrawing the solid sludge occasionally.

(1) *Anaerobic Methods of Sewage Disposal for Towns and Cities.*—The **Imhoff Tank** (Fig. 17) is the only widely used anaerobic method of sewage disposal for cities. The tank is constructed of concrete and occupies an excavation in the ground. It is a sort of two-storied struc-

ture. But the upper *floor* is not level. It slopes downward from the sides toward the center. The portions from the sides do not entirely meet in the center, leaving a narrow space through which solid particles in the sewage from above may settle down into the chamber of the first story. The sewage, or **influent,** slowly flows from one end of the tank to the opposite end, requiring several hours to make the passage of a few yards. During the several hours of very slow movement the solid particles settle to the floor of the second story and drift downward and into the chamber of the first story. The total depth of the tank is some 30 feet and the sewage fills the structure to within 2 or 3 feet of the top. In the deep water of the first story there is a greatly reduced oxygen supply in solution in the water. Therefore, anaerobic bacteria live in the lower depths in great numbers. These bacteria change most of the solid matter to fluids and gases. It is essentially a process of liquefaction and gasification. (Note the accompanying figure and determine what becomes of the gases as they make their way upward through the sewage in bubbles.) Only a slight portion of the solid matter remains solid on the first floor of the tank and this is termed **sludge.** The sludge is allowed to run out through underground pipes once in a few months. The water leaving the tank at the end opposite to that at which it entered is spoken of as **effluent.** The effluent leaving the Imhoff tank has lost most of its solid matter and is fairly clear water. But it does still possess much putrescible organic matter in solution and still retains about one-third of the number of bacteria which were in the influent. Germs of disease thus may pass through the Imhoff tank, or at least theoretically they may. Therefore problems in connection with the Imhoff treatment are to reduce further the bacterial count of the effluent and to convert the remaining putrescible organic matter into a more stable and non-putrefiable condition. How these two objects are obtained we shall consider later.

(2) *Aerobic Methods for Cities.*—The **sprinkling filter,** also called **trickling filter** (Fig. 18), is not used alone. It is used in connection with the effluent of the Imhoff tank. Many cities, which have the Imhoff method of disposal, pass the effluent of the tank through a trickling filter. In this process the effluent from the tank is sprayed by means of pipes upon beds of broken rock, these beds being several feet deep. While the water containing much putrescible matter is trickling down through the rock bed, bacteria living on the surfaces of the stones convert some of the unstable organic matter into more stable forms—nitrates, carbonates, sulphates, etc. The aerobic process is thus a mineralization process. These substances do not make good food for bacteria and

thus not so many of these organisms are found in the effluent of the sprinkling filter. The effluent of a trickling filter, therefore, does not give rise to putrefaction to a great degree. Besides the chemical work produced by the aerobic bacteria, also physico-chemical reactions occur which are independent of the bacteria. The physico-chemical processes cause the precipitation of organic matter and perhaps produce other changes. The trickling filter removes 70 to 90 per cent of the bacteria in its influent, although as indicated above, it does not convert all the putrescible matter into stable form. Such being the case, the effluent of the trickling filter is in a safer condition to be turned into a neighboring stream than was the effluent of the Imhoff tank.

The effluent of the trickling filter is also less likely to be detrimental to the fish life in such streams than is raw, untreated sewage or even the effluent of the Imhoff tank which is not further treated. If the water in which fish live contains large amounts of organic substances,

Fig. 18.—Typical section of a sprinkling Filter. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton and Co., New York.)

the oxygen of the water is absorbed when bacteria decompose those substances. Fish may thus be destroyed for lack of oxygen in solution in the water.

Another method of sewage disposal depending upon the work of the aerobic bacteria is that of the **activated sludge tank.** Some cities use the activated sludge tank alone as the only treatment given their sewage. This is a newer method of treatment than that of the Imhoff tank or trickling filter, but is quite rapidly becoming one of the chief methods of sewage disposal in this country. In the activated sludge process the sewage is run into large concrete tanks, which have portions of their floors constructed of a porous earthen material. Beneath the porous earthen areas in the floor are compressed air chambers. Compressed air passes up through the porous material into the sewage, which stands 10 or 12 feet deep. The air bubbles pass upward through the sewage, causing it to appear as if boiling. This aeration process is continued for

several hours. The aeration treatment allows great numbers of aerobic bacteria to produce chemical changes in the putrescible organic matter, converting it into nitrates, carbonates, sulphates, etc., the same products as those formed in the trickling filter. Solid particles of matter in the sewage flock together to form larger particles which settle to the bottom of the tanks as sludge. Through large pipes underground, the sludge is drawn out of the tanks occasionally. The activated sludge process reduces the bacterial count about 80 to 90 per cent, and is more efficient in this respect than the Imhoff tank, when the latter is used alone. The effluent of the activated sludge tank contains much less putrescible matter upon which bacteria might thrive or which might injure aquatic life than that of the Imhoff and sprinkling filter, even when combined in the treatment process.

The Imhoff is costlier to construct but its maintenance cost is almost *nil.* The activated sludge plant costs much less in the construction, but its maintenance cost is comparatively high, for machinery must be used to supply the compressed air and salaries must be paid to men to operate the machinery. The Imhoff tank operates itself and needs only occasional attention.

(3) *Chemical Treatment.*—Chemical methods of sewage treatment consist mostly of running chlorine into the effluent from the Imhoff tank or from the trickling filter, or from the activated sludge tank. Such chlorination is for the purpose of killing the bacteria which remain in the effluent.

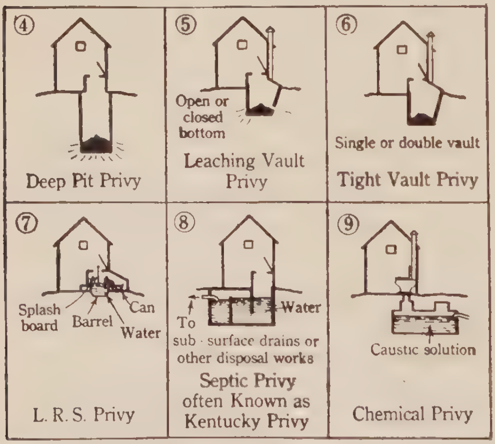
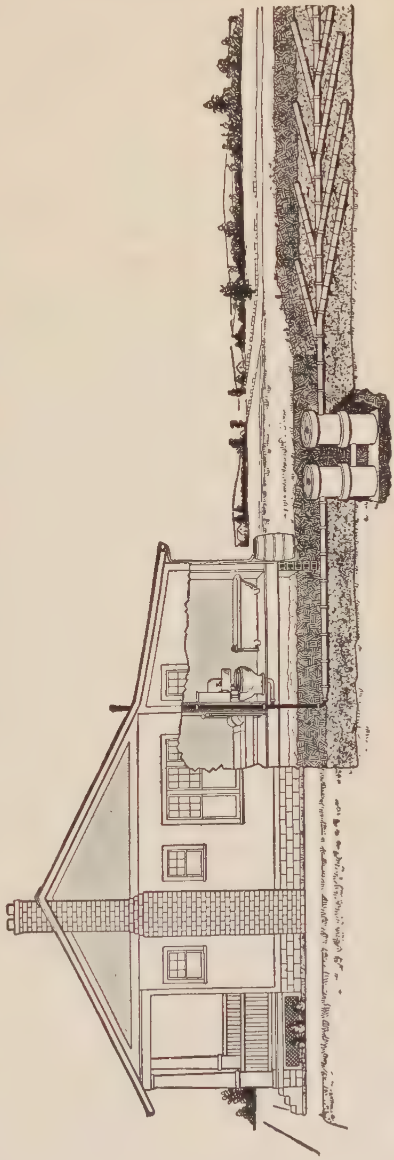


FIG. 19.—Types of sanitary privies. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton and Company, New York.)

Some cities treat their sewage only by the Imhoff method; others combine the Imhoff and sprinkling filter methods. Still others treat by the activated sludge method only while some treat by activated sludge plus chlorination. But the most approved methods of treatment combine either the Imhoff, trickling filter, and chlorination; or combine the activated sludge method with chlorination. Perhaps the latter

combination is the most efficient in rendering sewage non-putrescible, safe for the preservation of aquatic life, and safe for the public health.



Courtesy Southern Sewer Pipe Works.

FIG. 20.—Complete layout for a home septic tank installation, showing tank and sub-surface disposal field. (See also Fig. 21.)

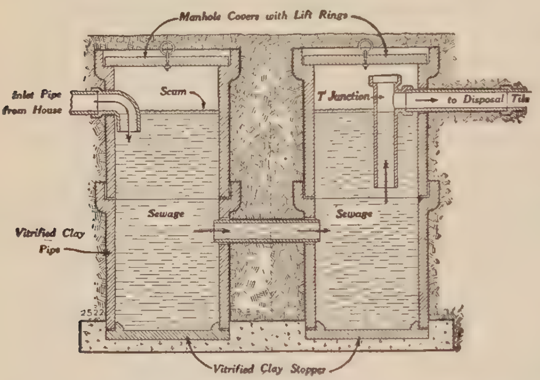
Home Sewage Disposal Methods.—(Fig. 19.) For the individual home in the country or in the small town where there is no sewerage system, there are several approved methods for disposal of sewage.

(1) *The Cesspool.*—A cesspool is an excavation into the ground, not unlike a well of large diameter. It is covered over with heavy boards and concrete and perhaps earth. The sewage from the home is run by underground pipes into this structure. The water is absorbed by the surrounding earth. Disadvantages are that the sewage might reach a neighboring well from the cesspool and thus contaminate a water supply; or, in times of continued rain the cesspool may fill with water.

(2) *The Septic Tank.*—(Figs. 20 and 21.) This is essentially an anaerobic method of treatment. The sewage is poured into a relatively long underground tank. In passing slowly from one end of the tank to the other, the sewage requires a period of several hours or a few days. During this slow passage, solid particles settle to the bottom of the tank and anaerobic

bacteria convert the organic matter into gases and fluids as in the Imhoff method. The effluent of the septic tank passes out into underground branching tile pipes which empty their load into the soil. There is always a danger that the effluent from a septic tank may contaminate a water supply. But the septic tank is a more desirable method of disposal than the cesspool.

(3) *Privies.*—The *pit* privy is of cheap construction and a fairly safe method. Such a privy has a deep pit dug into the earth beneath it. The pit is made proof from house flies by means of close construction or wire screen. The seat cover is so constructed that it falls closed when not in use.



Courtesy Southern Sewer Pipe Works.

FIG. 21.—Septic tank of vitrified tile. Two-section tank has sufficient capacity for 6 people. An additional section may be added to care for not more than 10 people. (See also Fig. 20.)

Another type of privy has a concrete or brick vault beneath. The vault is partly filled with water. There may be more than one chamber in the vault, one chamber so constructed that no solid matter passes into the second chamber. The effluent from the second chamber may be siphoned into underground tiles intermittently. Such a privy as this is recommended by the Kentucky State Board of Health (Fig. 19). It is a very desirable type.

(4) *Chemical Treatment.*—Perhaps the most approved method of sewage disposal for the country home is the **chemical closet.** This consists of a metal cylindrical tank placed beneath the bathroom of the house and the tank partly filled with water. The seat is directly over the tank. A pipe is provided to prevent odors entering the bathroom. A quantity of alkali, caustic soda, for instance, is dropped into the tank about once in 6 months. The alkali destroys the solid matter and any disease germs. In some chemical closets lysol or other coal-tar disinfectants are used. The effluent passes into underground drains and is absorbed by the earth. Such a toilet costs something like $100, installation included. The caustic soda costs only about $5 per year.

Any of the methods for country homes described above are adapted for use by country churches, schools, or tourist camps and resorts.

The old type open privy is a menace to the health of a community and should not be tolerated. It is a focus of infection for typhoid, dysentery, and in the South, hookworm. Possibly also it disseminates tuberculosis. How?

Many investigations in cities have shown that there is much more typhoid in those sections of the cities where there is no sewerage than in those sections having a sewerage system, thus revealing the importance of sanitary methods of sewage disposal.

OPTIONAL STUDIES

The Paratyphoid Fevers

The paratyphoid fevers very closely resemble typhoid. In fact, they cannot be distinguished from typhoid by the physician, without bacteriological examination. The causal agents of the paratyphoids are two bacilli very like *Bacillus typhosus.* The exit of the causal agents from the body of the patient or carrier, and the entrance of the causal agents into the body of a prospective patient are similar to those of typhoid. The agents of transmission are likewise the same as for typhoid. The period of incubation is four to ten days, averaging about seven days. What has been said of the period of communicability for typhoid is applicable also for the paratyphoids. The measures for prevention of the two paratyphoids are identical with those for the prevention of typhoid fever.

Bacillary Dysentery ("Flux")

The causal agent of this disease is *Bacillus dysenteriae.* The source of infection, the exit of the causal agent from the body of the patient or carrier, and the entrance of the causal agent into the body of the prospective patient are similar to those of typhoid. The incubation period is from two to seven days. Methods of prevention include isolation of patients in screened rooms and concurrent disinfection of the bowel discharges and of clothing, eating utensils, and other objects that come in contact with the patient, using those methods of disinfection suggested for typhoid. Attendants upon patients must take care to disinfect the hands and must avoid handling of food. As another general measure of prevention, elimination of fly-breeding places is important.

Amebic Dysentery ("Bloody Flux")

The causal agent is a parasitic ameba, known as *Endameba histolytica.* The source of infection, exit of causal agent from the body of the patient or carrier, the entrance of the causal agent into the prospective patient's body, and the agents of transmission are essentially the same as those of typhoid fever. The incubation period is unknown. Measures of prevention include concurrent disinfection of

bowel discharges, and fomites which come in contact with the patient, using such measures of disinfection as are used in typhoid. Among the general measures for prevention are the boiling of drinking water if there is reason to suspect its quality, and the protection of the water supply against any possible contamination. Patients or carriers should be prohibited from handling foods, especially those which are not to be cooked after the handling. Concerning the geographic distribution of this disease, it is confined mostly to tropical and sub-tropical countries. In fact, it is frequently termed "Tropical Dysentery." This dysentery is quite prevalent in our Southern States, and is occasionally found in the northern part of our country. Amebic dysentery is a more serious affection than bacillary dysentery. The parasitic amebae burrow into the intestinal wall and thus produce a great deal of injury to the intestines and cause bleeding, which accounts for the disease sometimes being known as "Bloody Flux." The disease is frequently difficult to cure because of the fact that drug remedies fail to reach some of the amebae which are embedded in the wall of the intestine.

Asiatic Cholera

The causal agent of Asiatic Cholera is *Spirillum cholerae.* The source of infection, exit of causal agent, entrance of causal agent, and agents of transmission are identical with those of typhoid. Period of incubation is 1 to 5 days, usually 3 days. Methods of prevention are the same as those for the prevention of typhoid. Asiatic Cholera is chiefly confined to Asia and Eastern Europe. Occasionally the disease is found at our own seaports, having been brought on ships from foreign ports. This disease is an acute infection of the intestine characterized by violent diarrhoea and rapid collapse.

Hookworm

Causal Agent.—The American hookworm, known technically as *Necator americanus.*

Source of Causal Agent.—The intestines of man and certain animals, but those of man are the chief and most important source.

Exit of Causal Agent from the body of patient or carrier is by way of the bowel discharges.

Entrance of Causal Agent into the body is usually through the skin of the bare feet or hands, sometimes through the mouth in contaminated drinking water.

Agents of Transmission.—Occasionally drinking water, but usually the larvae or young hookworms burrow through the skin of the hands or feet, as already indicated.

Incubation Period.—Seven to ten weeks.

Period of Communicability.—As long as the parasite or its eggs are in the intestines of an infected person. Contaminated soil may remain capable of infecting for as long as five months, provided there is no freezing.

Life History of the Parasite.—The habitat of the hookworm is the intestine of man (and of other animals). The female hookworm lays a few hundred eggs. These eggs are discharged by the infected person with the feces. If deposited upon a warm, moist sandy soil the eggs hatch within a few days, producing very tiny larvae which are invisible to the unaided eye. This larva moults or sheds its sheath twice. It is

then said to be in the *infective* stage. The larva while in the infective stage is barely visible to the unaided eye, appearing like a tiny short fiber. In this stage of development the larva burrows its way through the tender skin between the fingers or between the toes of a bare foot and produces an intense itching, known in the South as "ground itch." After passing through the skin the larva enters lymph spaces or blood vessels and is carried to the heart and from the heart through the pulmonary arteries to the lungs. In the lungs the larva burrows its way into the open air passages and is carried up into the mouth, thence swallowed and reaches the intestine where it becomes an adult hookworm. The adult hookworm is about half the length and one-half the diameter of a pin. The worms with three peculiar rasping "teeth" draw blood from the wall of the intestine, which serves the parasite as food. It is believed that the parasite produces a toxin which causes the anemic appearance, physical debility and mental degeneration, of the person who is infected with a few dozen of parasites. There is no multiplication of the parasites in the intestine; that is, the eggs do not hatch within the intestine, due to a lack of sufficiency of oxygen.

Measures for Prevention.—(*a*) *Measures concerning the infected person and his environment:* (1) There should be microscopic examination for hookworm eggs in the bowel discharges of the person suspected of infection. (2) Sanitary disposal of bowel discharges of the infected individual to prevent contamination of soil and water. (3) Treatment of the infected individual to rid the intestine of the parasite and its eggs.

(*b*) *Public measures for prevention:* (1) Education of the populace as to the danger of soil pollution. (2) Prevention of soil pollution by installation of sanitary methods for disposing of human discharges. (3) Personal cleanliness and the wearing of shoes by children, and others, who live in hookworm localities.

Incidence.—Hookworm is confined to tropical and sub-tropical countries and to mines in more temperate regions. In our own country it is almost wholly confined to the Southern States. A recent survey made in one of the Southern States indicates that one-third of the children of some communities are infected with hookworm. A few years ago, it was estimated that there were 2,000,000 cases of hookworm in the South, but the disease is being eradicated quite rapidly. Our Southern hookworm area extends from the eastern portions of Oklahoma and Texas eastward to the Atlantic. It is believed that the hookworm was brought to America from Africa by negro slaves.

SUMMARY STATEMENT

The diseases belonging to the group disseminated by human excreta are typhoid, paratyphoid, the dysenteries, cholera, and hookworm. The infections disseminated by the alvine discharges are almost wholly preventable, if not entirely so, as shown by a large number of cities, especially, which a few years ago were great hot-beds for these diseases. Many cities have almost entirely wiped out the infections of this group by instituting three measures of prevention: (1) Safe sewage disposal. (2) Purification of water supplies. (3) Pasteurization of milk. Considered as a group, preventive science has made more progress

toward the conquest of these diseases than of any other group. When all communities adopt the scientific measures which many cities have already adopted, these diseases probably will disappear altogether, just as completely as yellow fever has been eliminated from the Western Hemisphere.

The primary or basic measure of prevention for this group of infections is the safe disposal of human excreta.

Important secondary measures are: guarding of water supplies and purification of the water; pasteurization of milk; absolutely clean hands, especially on the part of those who handle foods; elimination of house-flies, particularly in small communities where no efficient sewage disposal is had; and vaccination, for typhoid and cholera, especially.

CHAPTER III

DISEASES DISSEMINATED BY DROPLETS AND HOW TO AVOID THEM

THIS group of diseases, as a group, constitutes the greatest scourge of the human race. They occur most in temperate climates, that is, most of them do, especially where the temperature varies rapidly. They are not wholly distributed by droplets of the nose and mouth, but the droplet is the usual method of dissemination. Droplet infection occurs only by *direct contact*, that is, in the same room with, or within a few feet of, the patient or carrier. Most of the diseases of this group are not contracted at more than a few feet, or a few steps at most, distant from the patient. There is no such thing, for instance, as contracting smallpox or measles while on the street and passing a house where these diseases exist. One may safely be in a distant part of the same house with such diseases. On the other hand, the tubercle bacillus, under favorable conditions of moisture and darkness, may live for weeks or even months to cause an infection. Sometimes this group is referred to as the " respiratory group," meaning that their causal agents are taken into the body through the respiratory tract; it does not mean that all are diseases of the respiratory tract or organs.

This group of infections as a whole is not preventable to the high degree that those of the alvine discharges are. There are some members of this group, however, which are almost entirely preventable, such as tuberculosis, diphtheria and smallpox. Besides these three, the group includes pneumonia, influenza, " colds," whooping-cough, measles, mumps, meningitis, scarlet fever, trachoma and some others which are not considered here.

The ease with which some of these diseases gain a hold on the body depends to a large degree on ventilation and temperature of the environment of the body, as factors in lowering the body's capacity to resist the causal agents. One can demonstrate this for himself with regard to " colds " particularly by personal experimentation.

The germs which cause several of these diseases are present in throats a large part of the time, awaiting an opportunity to multiply and gain

ascendancy over the body's resistance. This is true of those micro-organisms causing pneumonia, meningitis, scarlet fever, and perhaps others. The tubercle bacillus may lie dormant in the human body for years before attaining its ascendancy. Hence, prevention lies largely in maintaining a strong body resistance, that is, the maintenance of a high capacity on the part of the body to produce immune substances which will inhibit the germs or their deleterious products.

Everyday Methods of Dissemination.—The following taken from Professor Rosenau and quoted by him from Dr. Chapin shows how easily we commonly and unconsciously in our daily life transmit diseases whose source is the discharges of the nose, throat, and mouth:

"Not only is the saliva made use of for a great variety of purposes, and numberless articles are for one reason or another, placed in the mouth, but, for no reason whatever, and all unconsciously, the fingers are with great frequency raised to the lips or the nose. Who can doubt that if the salivary glands secreted indigo, the fingers would not continually be stained a deep blue, and who can doubt that if the nasal and oral secretions contained the germs of disease, these germs will not be almost as constantly found upon the fingers? All successful commerce is reciprocal, and in this universal trade in human saliva the fingers not only bring foreign secretions to the mouth of their owner, but there, exchanging it for his own, distribute the latter to everything that the hand touches. This happens not once, but scores and hundreds of times during the day's round of the individual. The cook spreads his saliva on the muffins and rolls, the waitress infects the glasses and spoons, the moistened fingers of the peddler arrange his fruit, the thumb of the milk-man is in his measure, the reader moistens the pages of his book, the conductor his transfer tickets, the 'lady' the fingers of her glove. Every one is busily engaged in this distribution of saliva, so that the end of each day finds this secretion freely distributed on the doors, window sills, furniture, and playthings in the home, the straps of trolley cars, the rails and counters and desks of shops and public buildings, and, indeed, upon everything that the hands of men touch. What avails it if the pathogens do die quickly? A fresh supply is furnished each day. Besides the moistening of the fingers with saliva and the use of the common drinking cup, the mouth is put to numberless improper uses which may result in the spread of infection. It is used to hold pins, a string, pencils, paper, and money. Lips are used to moisten the pencil, to point the thread for the needle; to wet postage stamps and envelopes. Children 'swap' apples, cake, and lollipops, while men exchange their pipes and women their hatpins. Sometimes the mother is seen 'cleansing' the face of her child with her saliva-moistened handkerchief, and perhaps the visitor is shortly after invited to kiss the little one.

"Children have no instinct of cleanliness, and their faces, hands, toys, clothing, and everything that they touch must of necessity be continually daubed with the secretions of the nose and mouth. It is well known that children between the ages of 2 and 8 years are more susceptible to scarlet fever, diphtheria, measles, and whooping-cough than at other ages, and that one reason for this may be the great opportunity that is afforded by their habits at these ages for the transfer of the secretions. Infants do not, of course, mingle freely with one another, and older children do not come in close contact in their play, and they also begin to have a little idea of cleanliness."

DIPHTHERIA

Causal Agent.—*Bacillus diphtheriae.*

Source of Causal Agent.—The discharges of the nose and throat of patients and of carriers, and possibly the throats of cats and chicks.

Exit of Causal Agent.—By means of droplets thrown out in coughing, sneezing, or even in speaking in conversational tones. Also, by kissing, toys, pencils, food, fingers, spoons, cups, handkerchiefs, or other objects which might have come in contact with the nose and mouth.

Entrance of Causal Agent to the body of the potential patient is gained by inhalation of droplets from persons in close contact, or by means of objects freshly soiled with discharges of the nose or throat of patient or carrier.

Agents of Transmission are droplets from nose or throat of the patient or carrier, or articles freshly soiled with such discharges. Also, milk may serve as an agent of transmission from a patient or carrier who may be handling such milk and who may contaminate it.

Incubation Period is usually 2 to 5 days.

Period of Communicability is until virulent bacilli have disappeared from the discharges of nose and throat of patient or carrier. In about three-fourths of cases of diphtheria, the bacilli disappear from the nose and throat within two weeks after disappearance of symptoms. But in some cases diphtheria bacilli may remain within the nose or throat for 2 to 6 months after disappearance of disease, which condition constitutes a carrier.

Early Symptoms of Diphtheria.—For the benefit of teachers in the schools the early symptoms may be stated. Onset may be rapid or gradual. Sore throat, great weakness, and swelling of the glands of the neck near the angle of the jaw are pronounced symptoms. The back of the throat, the tonsils or the palate may show gray patches about the color of grayish kid leather used for gloves. Or, there may be almost no symptoms of disease. In the more advanced stage there is acute toxemia.

Exclusion from School.—The patient should be excluded from school till recovery and furthermore till two swabs and cultures from the nose and throat show no diphtheria bacilli. The cultures should be made at least 24 hours apart. Any other child in the family of the patient should be excluded till two successive cultures show no bacilli. Children known to have been exposed at school should be excluded till two cultures show negative.

Measures for Prevention.—Let us recall that the measures for preventing or controlling a given disease are determined by four factors in its dissemination: source of causal agent, route of exit of causal agent from the body of the patient, route of entrance to the body of the prospective patient, and the agents of transmission. These lead logically to the measures of prevention.

(*a*) *Concerning the Patient and His Environment.*—(1) Isolation and quarantine of patients and carriers. Patients should not be released until bacteriological examinations no longer show diphtheria bacilli to be present in the nose or throat. If a bacteriological examination is not possible, cases may be released with fair degree of safety 16 days after onset of the disease. (2) Immunization of all contacts who are shown to be susceptibles by the Shick test. The antitoxin is used to immunize persons after exposure to the disease. (3) Concurrent disinfection of all articles which have been in contact with the patient and all articles soiled by his nasal and throat discharges. (4) Terminal disinfection at the end of the illness by airing and sunning of the sick room and cleaning the room's floor with approved disinfectant followed by thorough washing with water and soap. The disinfectant may be a 10 per cent formalin solution or a 1 : 1000 solution of mercuric chloride. Perhaps it would be better to remove wall paper of the sick room.

(*b*) *Public Measures for Prevention.*—(1) Pasteurization of milk supplies. (2) Giving of the Shick Test to persons exposed to the disease, followed by active immunization of all susceptibles with toxin-antitoxin or with toxoid. (3) Active immunization of all children by the end of the first year of age with toxin-antitoxin or with toxoid; also, immunization of all school children. (4) Discovery of carriers among contacts and curing of such carriers, if possible. Removal of defective tonsils or adenoids frequently causes the carrier condition to cease. Carriers who continue to harbor the bacilli in spite of treatment should be instructed in hygienic measures designed to prevent infection of other persons.

Incidence.—Our knowledge of diphtheria and its prevention is perhaps as complete and thorough as that of any other infectious disease. Because of its peculiar nature and its peculiar mode of transmission, the disease will not probably soon be eradicated; but there is little excuse for failure to reduce its incidence greatly during the next few years, with the advent of toxin-antioxin and toxoid as active immunizing agents. In fact, the New York State Board of Health has recently adopted as a slogan, "No diphtheria by 1930." During the 1890's diphtheria in the most progressive communities made a remarkably

sharp decline in fatality and has declined steadily since, due to the advent of antitoxin as a curative agent. As an illustration, note the accompanying table.

DIPHTHERIA DEATH RATES PER 100,000 POPULATION

(Antitoxin came into general use about 1893–1895)

	1890 1894	1895–1899	1900–1904	1905–1909	1910–1914	1915–1919	1920–1924	1925	1926	1927
Chicago	117.3	69.7	33.9	27.0	37.9	31.2	17.5	8.0	7.3	14.1
New York City	134.4	85.8	58.0	40.0	28.0	21.8	14.0	10.8	8.1	12.0
Cambridge, Mass.	58.0	71.9	46.7	25.3	23.8	12.9	8.9	5.8	0.8	0.0
New Orleans	51.3	17.1	11.5	10.2	19.6	11.6	6.5	6.8	6.4	15.1
St. Louis	67.7	62.9	43.3	19.4	23.7	24.4	16.1	11.2	13.1	8.6
Dallas	21.8	16.0	16.9	8.1	6.9	7.4	8.3	3.6	11.8	8.5
San Francisco	54.8	21.6	44.2	14.4	9.2	17.0	23.0	6.6	6.4	3.6
Nashville	28.4	30.1	13.9	10.3	7.3	8.9	8.0	6.6	20.4	12.3
Denver	130.2	27.3	29.6	20.8	10.2	6.7	23.2	15.7	10.5	7.9

Since toxoid and toxin-antitoxin immunization is now becoming common, both the case rate and fatality rate are due to make another sharp decline in the next few years.

The greatest incidence for diphtheria is between the ages of 5 and 7 years. However, diphtheria frequently attacks adults, or even the aged. George Washington died at the age of 67, and died of diphtheria. Diphtheria becomes most prevalent during the autumn months, its curve beginning to rise immediately on the opening of schools. It is a cold weather disease. Abnormal conditions of the nose and throat membranes prevalent in winter favor the penetration of diphtheria bacilli and their multiplication. Hence, predisposing factors are sore throat, adenoids, dust or other irritants, and "colds."

How the Bacilli Produce the Disease.—Diphtheria bacilli remain on the lining membranes of the nose and throat, very rarely entering the tissues or blood stream. Within their bodies they form poisonous chemical substances, **toxins.** The toxins are extruded from the bodies of the bacteria through their body surfaces and thus come in contact with the lining membranes of the nose or throat, or both. These toxins are soluble and are absorbed into the tissues and blood stream of the patient. Hence, the toxins pervade all the tissues of the body and produce the symptoms of disease. Thus diphtheria is a **toxemia**, that is, the exotoxin invades the blood stream. The toxemia, or poisoning, may

produce death. Or, the membranes of the larynx or trachea (wind-pipe) may become swollen to such a degree that breathing is obstructed and the patient, in this case, may suffocate or asphyxiate. The diphtheria bacillus is quite easily killed under adverse conditions, possessing little resistance when out of its normal habitat, the throat.

How Diphtheria Toxin May Be Obtained.—If diphtheria bacilli are grown for several days in beef-broth, they increase greatly in numbers, and secrete toxin which is extruded through their body surfaces into the broth. The broth may now be filtered through an unglazed porcelain filter. The bacilli do not pass through the filter with the broth, but the exotoxin does pass through the filter. Hence the filtrate contains diphtheria toxin. This toxin may be used to develop antitoxin in the bodies of animals and to make toxin-antitoxin and toxoid.

How Antitoxin Is Obtained.—Antitoxin is produced in the bodies of animals, usually horses, in the following manner: small quantities of beef-broth filtrate containing diphtheria toxin, as described above, are injected into the body of a horse with successive injections during a period of several weeks. The injected doses are increased in size from time to time. The toxin on injection into the body of the horse stimulates the cells or tissues of the animal to produce an anti-substance or immune substance which is to neutralize the action of the toxin by combining with it chemically and forming a harmless compound. The anti-substance is called **antitoxin.** As injections of the toxin into the horse continue during the weeks, the tissues produce more antitoxin than needed to neutralize the injected toxin. The horse's blood comes to possess a large amount of excess free antitoxin in the fluid portion, serum or plasma, of the blood. After the development of relatively large quantities of antitoxin in the serum of the horse's blood, the animal is bled and the corpuscles are separated from the fluid portion, or serum. The separated serum contains the antitoxin produced by the tissues of the animal, and this serum is the so-called diphtheria antitoxin, which is used for the cure of diphtheria. Diphtheria antitoxin is thus a *serum*, and not a *vaccine*.

It may be added that a vaccine consists of living, injured, or killed bacteria. As indicated above a serum consists of blood serum or plasma which contains antisubstances or antibodies. The student should fix well in mind this differentiation of a serum and a vaccine.

How Antitoxin Cures Diphtheria.—When diphtheria antitoxin, produced as described above, is injected into the body of a patient who has diphtheria, the antitoxin soon becomes diffused through the body. The antitoxin thus comes in contact with the toxin which has also

diffused through the body from the throat of the patient. The antitoxin forms a chemical union with the toxin. The chemical compound formed by the toxin and antitoxin is harmless to the human body. Thus the function of antitoxin in the treatment of a patient is to neutralize the toxin and destroy its potentiality for harm. But the antitoxin does not destroy the bacilli; they " run their course " and disappear. Consider the meaning of the term, *anti-toxin.*

The time element in the administration of diphtheria antitoxin is of great importance in the saving of life. The longer the administration of antitoxin is delayed the less the affinity of the antitoxin and toxin for each other. Hence, the longer the delay the less the likelihood of the two uniting to form the harmless compound. The table shows the percentage of deaths occurring with the administration of antitoxin at various stages of the disease:

Administered during first	24 hours after onset, death rate none
Administered during second	24 hours after onset, death rate 2%
Administered during third	24 hours after onset, death rate 4 to 5%
Administered during fourth	24 hours after onset, death rate 8 to 10%

Passive Immunity and How It Is Produced.—One may be immunized against diphtheria by having antitoxin injected beneath the skin. In this case the anti-substance is introduced into the body from the outside and the human body has no part in the production of the antitoxin. In other words, the body is inactive, or *passive*, so far as the production of antitoxin is concerned. Because of the fact that the body is passive during this immunizing process, it is termed **passive immunity.** But passive immunity lasts for only about 3 to 6 weeks, because the antitoxin which was introduced into the body disappears within that period of time. However, had the immunized person received diphtheria bacilli into his throat during the period of immunity, the antitoxin would have neutralized any toxin which might have been produced by such bacilli.

Active Immunity and How It Is Produced.—Diphtheria **toxin-antitoxin** is used for the production of **active** immunity. The toxin-antitoxin is a loose chemical union between toxin and antitoxin. But there is slightly more toxin in the mixture than antitoxin. When the toxin-antitoxin is injected beneath the skin of the person being immunized, the excess toxin stimulates the body cells or tissues to produce antitoxin. Perhaps, also, as the weeks pass the combined toxin slowly breaks away from its loose union with antitoxin and itself stimulates the body cells further in the production of antitoxin. Excess quantity

of antitoxin is produced and the excess pervades the tissues and blood stream. Thus, the body of the person being immunized becomes active in producing the immunity, and for this reason it is termed *active* immunity. The body tissues continue to produce the antitoxin for a number of years, probably as long as 3 to 6 years. Hence, active immunity is of much longer duration and more desirable than passive immunity. The effectiveness of the toxin-antitoxin in reducing the diphtheria death rate was shown recently at Auburn, New York. Auburn is a town of 40,000 population. Three years ago the city health department put on an intensive campaign to have toxin-antitoxin given all children found susceptible to diphtheria. For three years there was not a single death occurring from dipththeria.

Just recently a newer method of producing active immunity to diphtheria is beginning to establish itself in this country and it appears possible that this method may displace the toxin-antitoxin method. The newer one has the advantage of eliminating the use of the horse and of horse serum. The immunizing agent is called **toxoid** (also called **anatoxin**). Toxoid consists of diphtheria toxin, produced in the manner already described, to which is added a small amount of formalin (formaldehyde). The formalin destroys the poisoning power of the toxin but the toxin retains its capacity to stimulate the production of antitoxin by the body when injected. To immunize, the toxoid is injected hypodermically in two doses. The " shots " are given two or three weeks apart.

But passive immunization with antitoxin has the advantage, over active immunization with either toxin-antitoxin or toxoid, that immunity is produced much more quickly, the subject probably being immune immediately. It requires about 6 to 12 weeks for one to become actively immune. For this reason, antitoxin is used for immunizing exposed persons in an epidemic.

Active immunity is also produced by having the disease. Explain how such immunity is established in the body of the recovered patient.

Natural Immunity.—Before birth the embryo receives diphtheria antitoxin from the mother through the blood, provided the mother possesses antitoxin and is immune, as is the case with most adults. Only about 10 per cent of new-born babies are susceptible to diphtheria. After birth the infant continues to receive antitoxin from the mother through the milk. This constitutes only passive immunity for the infant. By the end of the second year of life the passive immunity has disappeared in 70 per cent of children. That is, about 70 per cent of chil-

dren at two years of age are susceptible to diphtheria. After this period, children begin naturally to form their own antitoxin and the percentage of susceptible children gradually decreases as they grow older. At 5 years of age only 40 per cent are susceptible; at 10 years, 30 per cent; and over 20 years of age, only 20 per cent are susceptible to diphtheria. After one has become immune as age advances, he is said to be *naturally* immune. An attack of diphtheria usually confers immunity for life; only about 6 per cent of those having had diphtheria have it the second time.

The Schick Test.—The Schick reaction is a test devised to determine whether a person is susceptible or immune to diphtheria. The test is made in the following manner: A small quantity of broth filtrate containing diphtheria toxin, produced in the manner described previously, is injected *within* the tissues of the skin, not under the skin. If the person is susceptible to the disease the toxin poisons a small area of the skin where the injection was made and a red inflamed area appears within a day or two, and disappears within a few days. But if the person is immune, that is, if he possesses antitoxin in his tissues, then the injected toxin will be neutralized by the antitoxin and no poisoned red area will appear. This is a very simple, highly useful, and harmless test.

Diphtheria Carriers are those who harbor the diphtheria bacilli in the throat but who themselves do not have the disease. Carriers become fairly numerous in time of diphtheria epidemics. But there are two general types of diphtheria germs, one type being capable of producing the disease and the other type not capable of producing diphtheria. The former type is termed *virulent* bacilli and the latter type is termed *avirulent*, or *non-virulent*, bacilli. Now, most carriers fortunately harbor avirulent bacilli. Tests in various communities have revealed that 1 to 3.5 per cent of the population are carriers of diphtheria bacilli. However, only one-tenth to one-twentieth of the carriers harbored virulent bacilli. Determination of whether diphtheria bacilli are virulent or avirulent is made by injecting the bacilli into a guinea-pig. Only the virulent organisms kill the guinea-pig. Carriers of virulent organisms present an important problem in public health. Those bacilli are usually associated with abnormal or diseased tonsils, nose, or throat. Many such persons cease to be carriers when the diseased tonsils or other parts are removed. However, some remain carriers after all methods of treatment have been used. Carriers must be taught hygienic measures to prevent infection of other persons by droplets, or otherwise.

Milk-borne Diphtheria.—A number of milk-borne epidemics of diphtheria occur in the United States each year. The milk may be contaminated by a carrier, or by a dairy worker who is nursing a case of diphtheria at the time. In a recent year an epidemic occurred at Austin, Texas, involving a number of students at the University of Texas. Investigation showed that the epidemic was due to diphtheria bacilli which were found in an old sore on the teat of a dairy cow. The bacilli from the sore had infected the milk. Further investigation showed that a diphtheria carrier had been milking this cow several weeks previously.

Control of an Epidemic in School.—The following main steps are the usual procedure in the control of an epidemic of diphtheria in a school. (1) Isolation and quarantine of cases. (2) Administration of the Schick Test to all suspected contacts. (3) Passive immunization of all susceptible contacts, with antitoxin. (4) Swabbing of noses and throats, followed by bacteriological examination, of all known contacts to discover any carriers. (5) Isolation and treatment of carriers. (6) Active immunization, with toxin-antitoxin, of all susceptible contacts, but not within three weeks after having received antitoxin. Or toxoid may be used for active immunization.

PNEUMONIA

Causal Agents.—There are several causal agents of pneumonia, the most serious one being the *Pneumococcus.* Pneumonia is caused by irritation of the bronchial tubes or lung tissue by certain kinds of bacteria, and there are several kinds which are capable of producing this irritation.

Nature of the Disease.—The irritation causes the secretion of fluid from the great network of blood vessels in the lungs. This fluid passes from the blood vessels into the air spaces and bronchial tubes, thus producing "consolidation," as the physician says. Fever and prostration are symptoms. As the filling of the air spaces with the fluid continues, the patient approaches asphyxiation or suffocation. Or, death may be the result of production of toxin by the invading bacterium, rather than by the secretion of fluid on the part of the tissues sufficiently to asphyxiate. As indicated above there are several kinds of bacteria which may gain entrance to the lungs and produce the irritation necessary for the formation of the fluid in the air passages which constitutes the pneumonic condition.

Source of the Causal Agent.—Droplets from the nose and mouth of patients or carriers of the offending bacteria.

Exit of Causal Agent from the body of patient or carrier is usually in droplets from the nose and mouth during fits of coughing or sneezing, or even in droplets from mouth in ordinary conversation.

Entrance of Causal Agent into the body of a potential patient is gained through the nose or mouth during inhalation. Also it is possible to transmit the germs on objects which may be passed from one mouth to another.

Agents of Transmission.—Droplets from nose or mouth of patient or carrier; articles freshly soiled with such discharges.

Incubation Period.—Two to 3 days or longer.

Measures for Prevention.—(*a*) *Measures Concerning Individual and His Environment:* (1) Maintenance of high degree of body resistance by regular hours of rest and sleep; a well-fed body with a well-balanced ration; and avoidance of excessive chilling of the body, or even feet alone; avoidance of overheated rooms. (2) Isolation of patient. (3) Concurrent disinfection of all discharges from nose and mouth of patient. The discharges may be deposited in papers or rags which then may be burned.

(*b*) *Public Measures for Prevention:* (1) Avoidance of unnecessary contact with crowds, especially in poorly ventilated rooms, during periods when much pneumonia is prevalent. (2) Avoidance on the part of the populace of the predisposing factors which may occasion pneumonia, which factors are discussed below.

Incidence of Pneumonia.—Pneumonia is second among the causes of death in the United States, second only to that of heart disease. About 10 per cent of all deaths are due to pneumonia. It occurs most in the winter and spring months. Why, do you suppose? It attacks all ages but its highest incidence and mortality are among the very young and the old. It attacks the healthy and unhealthy. It is more fatal among negroes than among whites.

Predisposing Factors.—There are a number of factors which may predispose or occasion pneumonia. Perhaps the most important predisposing factors are cold, wetting and chilling. Overheated rooms in winter are undoubtedly a factor in reducing the body's resistance to pneumonia. Other predisposing factors are fatigue, alcohol, irritating dust, and a poor state of nutrition. The alcoholic addict is likely to succumb quickly to pneumonia, sometimes within 24 hours from onset. "Colds" and influenza frequently precede the development of pneumonia. The diseases just mentioned and the predisposing factors

named reduce the body's capacity for resistance to the causal agents of pneumonia.

INFLUENZA

Causal Agent.—Undetermined.

Source of Causal Agent.—Fluids of the nose and throat.

Exit of Causal Agent.—Droplets from the throat and nose.

Entrance of the Causal Agent.—By inspiring droplets containing the causal agent. It is probable that objects, such as pencils, for instance, which are freshly contaminated and passed from mouth to mouth may transmit the causal agent.

Incubation Period.—Usually 24 to 72 hours.

Measures for Prevention.—(1) Isolation of patients. (2) Avoidance of droplet infection by avoidance of persons who carelessly neglect proper use of handkerchiefs in fits of sneezing and coughing. (3) Avoidance of crowds, such as those of the theater, school, and church in periods of epidemic influenza. (4) Avoidance of overheated rooms. (5) Judicious exercise. (6) Avoidance of predisposing factors, such as wetting, chilling, excessive fatigue, worry, etc.

Earliest Symptoms.—Fever, headache, backache, or aching of any or all parts of the body, and sometimes sore throat and running nose.

Hygiene for the "Flu" Patient.—Influenza is one of the most treacherous ailments to which man is subject. It may "settle" in various parts of the body and may lead to a prolonged illness or even permanent invalidism. It is equally notorious in its ability to break down and destroy the antisubstances in the body with which the latter defends itself against pneumonia. "Influenza begins with a cold, proceeds to pneumonia and ends, 'Here lies ———.'"

Little or nothing can be done for influenza with drugs. Prospect for complete recovery depends almost wholly on the hygiene practiced while ill and during convalescence. On first suspicion of "flu" it is wise to go to bed and drink heavily of fluids—water, lemonade, milk, etc. Fluids saturate the tissues of the body and later find their way out through the kidneys, carrying toxins in solution from the tissues. The patient with influenza, or pneumonia, needs fairly cool air for breathing and for the dissipation of the body heat at an optimum rate, in order to maintain the highest possible powers of resistance. Hence the sick room's temperature should be regulated with an accurate thermometer and maintained at about 65° F. If the room is heated by radiators or with hot air, then it may be necessary to admit moist air

from the outside through a window raised slightly. The patient must remain in bed from 2 to 4 days after the disappearance of all fever and other symptoms. Relapses of "flu" are fraught with hazard. Leaving the bed too early results in disaster with great frequency, as every physician can attest. All too often the patient considers himself well, after fever has disappeared, leaves the bed and house and is suddenly stricken down with pneumonia, which is one of the most dangerous affections to which man is disposed.

Of course, a physician should be called at the onset of influenza and his directions followed with religious precision.

Immunity conferred by the "flu" is of short duration, no longer than a few months.

What has been said above concerning influenza applies especially to the epidemic form of that disease, but it applies also in great degree to the endemic or sporadic form which is always more or less prevalent in any community during the winter season.

Incidence.—Influenza occurs most in winter. Like pneumonia, influenza attacks all ages and all types of physical condition. Influenza not often causes death directly; it reduces the body resistance and pneumonia follows. Influenza frequently occurs in great epidemics or even pandemics. In the pandemic of 1918–1919, 400,000 deaths occurred in the United States. Many more in proportion to population occurred in Asia. Professor Jordan estimates that there were 20,000,000 deaths throughout the world.

"COLDS"

Causal Agents.—There are probably several kinds of bacteria capable of producing "colds." Our knowledge of the exact cause or causes of colds is in a rather vague state at the present time.

Source of Causal Agents.—The discharges of the nose and throat.

Exit of Causal Agents.—By droplets from the nose and throat.

Entrance of Causal Agents.—By inspiration of droplets containing the causal agents and by freshly soiled articles brought in contact with mouth or nose.

Incubation Period.—Undetermined.

Period of Communicability.—Undetermined.

Predisposing Factors.—Dampness of clothing and resulting chill; chill by too rapid loss of heat from the inactive body in a draft of air; exposure to rooms of high temperature and dry atmosphere.

Nature of a "Cold."—This respiratory disease is believed to be produced by several kinds of bacteria, as already indicated. In some way the infection causes swelling of the lining membranes of the nose and throat, the swelling being due to the increased amount of fluid congested in those membranes. Some of the excess fluid exudes through the surface of the membranes to produce the " running " nose.

Physiological Causes of "Colds."—It is believed that colds may be produced by physiological derangements unrelated to invading bacteria. One may, for instance, experience congestion of the nasal membranes, with consequent sneezing and " running " of the nose, by merely sitting with the legs crossed for a protracted period of time. The leg which is crossed over the other suffers a retardation of blood flow to and from the foot, due to partial closure of blood vessels at back of the knee. In some manner the membranes of the nose become congested, sneezing occurs, and if the posture is much prolonged a cold may develop. But if one rises and restores the normal blood flow by stamping or exercising the offended leg, the incipient cold may stop.

Another example of physiological cause of incipient colds may be produced if one has opposite sides of the body heated unequally. If, as an instance, one stands with back to a warm radiator for several minutes sneezing and a cold begin. Yet if all surfaces of the body were warmed to the same degree with the back, as when one remains in an overheated room, the cold is not so easily provoked. Again, if a portion of the body surface is cooled more than most of the surface, a cold may be started. An example is the cold which is likely to develop if one sits on a cool surface.

But even though the body is chilled, if it is kept exercising no cold is likely to result. Football teams even play in cold rain without contracting colds. The spectator of a football game in the cold of late autumn who remains still is much more likely to " take cold " than if he stamped his feet, swung his arms and swayed his body. If his team is winning an exciting game he is comparatively safe from contracting a cold! Exercising the muscles produces heat.

If one is seized with a fit of sneezing, removing a part of the clothing, or going into another room of different temperature, or going out of doors, is likely to stop the sneezing. Otherwise, a severe cold may develop.

Measures for Prevention.—(1) Avoidance of mass infections by avoiding persons who show symptoms of " colds." (2) Avoidance of predisposing factors: excessively rapid heat loss from body by draft of air on the inactive body or by wetting of body; avoidance of overheated,

dry rooms in winter. (3) Cultivation of high state of resistance on the part of the body by judicious exercise, recreation, and wholesome diet. (4) Cold baths, which give exercise to, and increase the efficiency of, the heat-regulating mechanism. (5) Living under well-ventilated conditions, both day and night. (6) Colds in incipient stages may be checked by taking vigorous exercise till perspiration appears, then taking a hot bath, hot lemonade, cathartic, and going to bed for 24 hours. An aspirin tablet may be taken effectively, if one's physician considers it wise for that particular person to take aspirin.

Incidence.—Someone has recently estimated that there are as many as 100,000,000 pronounced cases of colds each year in the United States, and that the loss of labor due to colds amounts to 1 billion dollars per year. The Metropolitan Life Insurance Company kept an attendance record of about 6700 clerical employees in the home office. It has found that 42 per cent of the employees lost time each year on account of illness from colds. The average number of days of disability per person on the payroll for the year was nearly 2 days, and the average time lost for each case 2.2 days. In the Washington, D. C., public schools it was found that more than one-fourth of all absences were due to colds. It might be added that it was also found that respiratory disturbances caused nearly 40 per cent of all absences.

TUBERCULOSIS

Causal Agent.—*Bacillus tuberculosis.* There are two strains, or varieties, of this bacillus: the human strain, and the bovine strain (of cattle). There are also other varieties or strains of the tubercle bacillus found in birds and certain cold-blooded animals, but neither of these strains attacks man. The bovine strain does produce disease in man.

Source of Causal Agent.—Sputum and feces of patients with tuberculosis of lungs. The sputum is the most important in transmission of disease. Milk from tuberculous cattle in advanced stages of disease is a common source of the bovine strain of bacillus.

Exit of Causal Agent.—The sputum of the pulmonary patient of tuberculosis and feces of such patient. Exit is also by way of discharges of the kidney and from lesions of glands, bone, and skin, when such are present. Also milk of tuberculous cows.

Entrance of Causal Agent.—By being inhaled with contaminated droplets while in direct contact with an infected person. By being taken

into the digestive tract from contaminated fingers and with contaminated food and drink.

Agents of Transmission are contaminated food, drink, contaminated fingers, droplets, kissing, unsterilized eating utensils, pipes, toys, drinking cups, and perhaps flies and dust. Also, milk from tuberculous cows.

Incubation Period.—Variable, usually a few years.

Period of Communicability.—As long as the tubercle bacillus is eliminated by the sputum or other discharges from the patient. The bacilli are not found in the sputum until the disease has progressed to such a degree that the ulcer-like tubercles formed in the lungs by the bacilli become ruptured. Upon rupture of the tubercles the bacilli are then free in the open air-passages of the lungs and are brought to the mouth entangled in masses of sputum. An infected cow does not eliminate tubercle bacilli in milk during the earlier stages of the disease.

Measures for Prevention.—Prevention consists of two things: Avoiding mass infection and increasing the capacity of the body through hygienic living to resist any organisms present in the body.

(*a*) *Measures Concerning the Patient and His Environment.*—(1) Abundance of sunlight for those giving promise of tuberculosis. (2) Early recognition of the disease in the patient. This recognition should be made before the patient reaches the stage in which bacilli are discharged in the sputum, for such early recognition will prevent infection of other persons. (3) Isolation of such " open " cases as do not observe precautions necessary to prevent infection of other persons. (4) Concurrent disinfection of sputum. The sputum should be deposited in rags or paper and burned. Concurrent disinfection of handkerchiefs and clothing by boiling in water. Eating utensils of patient should be boiled, then washed separately; special utensils should be used. (5) Terminal disinfection by washing floor and furniture of patient's room with approved disinfectant such as 10 per cent formalin solution, or 5 per cent carbolic acid solution, or 1 : 1000 solution of bichloride of mercury. The room then should be thoroughly cleansed with hot water and soap.

(*b*) *Public Measures for Prevention.*—(1) Popular education as to methods of preventing tuberculosis. (2) Education of the public with regard to danger of infection in early childhood. (3) Pasteurization of public milk supplies and inspection of meats, especially of meat which is killed at the small local markets. (4) Elimination of tuberculous cows from dairy herds, such cows as are shown by the tuberculin test to be diseased. (5) Prevention of handling of foods by tuberculous persons, especially those foods which are to be consumed raw. (6) Provision by

cities and counties of dispensaries and visiting-nurse service for discovery of early cases, and for the supervision of cases in the homes. (7) Provision by cities and counties of hospitals for isolation of advanced cases and of sanatoria for the treatment and education of cases in the early

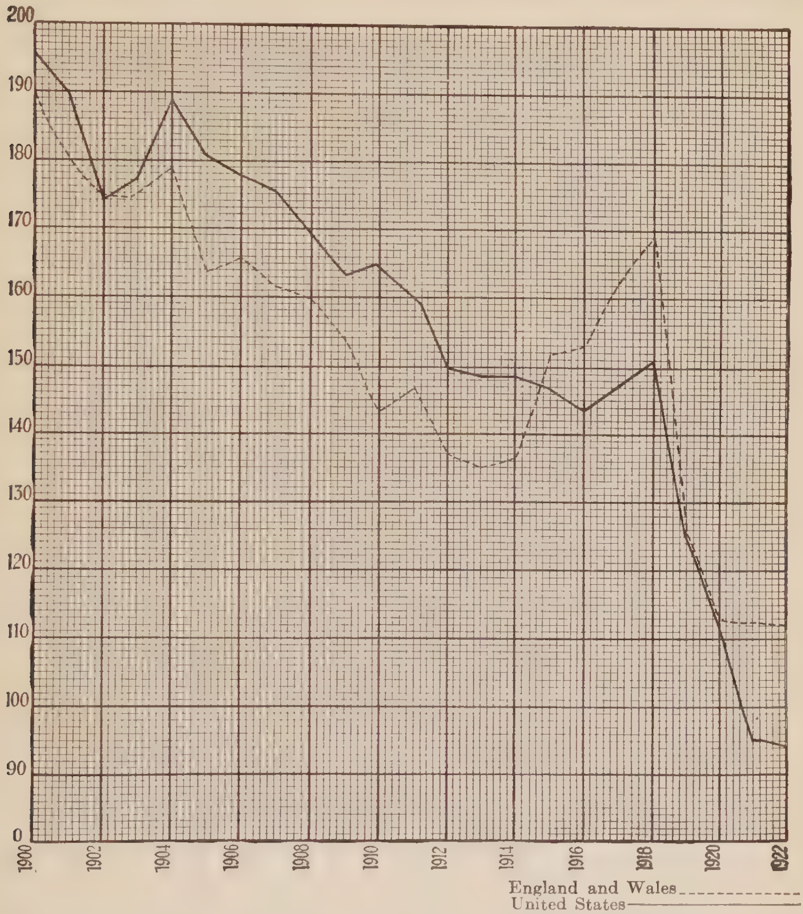


FIG. 22.—Tuberculosis (all forms) death rate per 100,000 in England and Wales and original registration Area in United States, 1900–1922. Note the effect of the World War. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton and Co., New York.)

stages. (8) Special classes in schools and preventoria for pre-tuberculous children. (9) Improvement of housing conditions and nutrition of the poor. (10) Ventilation and elimination of dust from places of employment and places of public assembly. (11) Education of the public in habits of hygiene. (12) Separation of babies from tuberculous mothers at birth.

Within recent years, Calmette, French physician and bacteriologist, has developed a vaccine which when given to babies born in tuberculous families reduces the incidence of tuberculosis among such babies much below that of babies born of non-tuberculous families. Calmette's vaccine is used only for babies, being given soon after birth. It is made of attenuated bacilli of the bovine strain.

(*c*) *Prevention of Development of Tuberculosis in the Person Already Infected.*—It has been shown that the vast majority of persons are, or have at one time been, infected with the tubercle organisms. The problem of the great majority of persons, then, is to maintain a body resistance which will prevent the bacilli from gaining ascendancy. Such prevention lies in wholesome and hygienic living; good ventilation, day and night; sunshine; sufficient rest and recreation; sleep of 7 to 8 hours daily and at *regular* time; wholesome, well-balanced diet; and exercise.

Early Symptoms.—The early symptoms of tuberculosis of the lungs are fever, usually highest in the afternoon; exhausted feeling; rapid loss of weight.

Incidence.—Tuberculosis is a disease of civilization. It is the consequence of unnatural living. "It is a disease of cattle in barns, not on the range; chickens in coops, not birds in nature; monkeys in zoos, not in the jungle; man in houses, not primitive races."

It is said that "tuberculosis loveth a shining mark." Note the following who have died of tuberculosis: Emerson, Ruskin, Elizabeth Browning, Pope, Voltaire, Molière, Chopin, Keats, Shelley, Byron, Goethe, Schiller, Balzac, Kant, Samuel Johnson, Washington Irving, Robert Stevenson, Kingsley, John Locke, Raphael, Heine, Thoreau.

Nearly 100,000 persons die each year in the United States of tuberlosis. It is estimated by the most conservative authorities that there are 10 times as many cases of tuberculosis as there are deaths occurring annually. It is further estimated that 9,000,000 of the present population of the United States are doomed to die of the "white plague." One-fourth of all the deaths occurring between the years of 15 and 60 are due to pulmonary tuberculosis alone. Economists estimate that the cost to the nation annually from tuberculosis deaths amounts to about $500,000,000.

Tuberculosis is chiefly a class disease, occurring most among the poor. Poor food, bad housing, crowding, overwork, and worry—these are the hardships which induce the development of tuberculosis.

Infection in Childhood.—Most bovine infection occurs in children, who are apparently more susceptible to the bovine strain of tuber-

culosis than adults. About 25 per cent of all tuberculosis in children under 5 years of age is of the bovine strain. The bovine strain is responsible for about 0.5 per cent of all the deaths due to tuberculosis. Bovine tuberculosis in man is usually a disease of lymph glands or bones, producing about one-tenth of the cases of tuberculosis of those parts. It is believed that tuberculosis of the lungs is rarely or never due to the bovine strain. The bovine strain of tuberculosis is received chiefly from milk of infected cows. It may also be gotten from meat, killed in the small local slaughter houses, which usually are not inspected.

But children are easily and frequently infected with the human strain. Children that crawl and play upon the floor are especially exposed to danger by carrying the dirt of the floor to their mouths with their fingers. Besides, children must be kissed by friends, acquaintances, and even strangers.

It should be stated that tuberculosis is not hereditary, in the proper sense of the term, that is, the tuberculosis bacillus does not pass from infected father or mother through the spermatozoan, or egg, to the progeny. However, the child before its birth may receive infection from the mother. Also, the child may inherit weakness for resisting tuberculosis. It has been shown that 70 per cent of all individuals who reach the age of 16 years are infected with tuberculosis. It is believed that the most of these receive their infections during early childhood.

Immunity.—Some races of men are more immune to tuberculosis than are others, Jews and Italians, for instance. Irish are more susceptible. It appears that man is almost immune to tuberculosis, for it usually requires several years after infection before development of symptoms. Besides, only a small portion of the 70 per cent who are infected at 16 years ever show symptoms of the disease.

Resistance of the Tuberculosis Germ.—If protected from the sunlight, the tuberculosis germ may live in dried sputum for a number of months. It may live as long as a year in water, though it does not multiply in water. In direct sunlight bacilli which are thoroughly exposed die in a few hours. In diffused sunlight they may live for several days. But tubercle bacilli embedded in large masses of thick sputum may be protected from the germicidal power of the sun's rays for a considerable period of time.

The Decline of Tuberculosis.—For three-quarters of a century, the decline of the tuberculosis death rate has been quite pronounced. In 1855, the tuberculosis death rate annually in Massachusetts was 500 per 100,000 population; in 1925 it was less than 100 per 100,000 population. In 1900, the tuberculosis death rate for the United

States was about 195 per 100,000 population, but in 1926 it was only 87.

Persistent effort on the part of a community may produce a sharp decline in tuberculosis, as has been demonstrated in a number of communities during recent years. To mention one such community: Framingham, Massachusetts, a city of 15,000 population, made special effort during a period of seven years to reduce its tuberculosis death rate, and during that period it reduced its tuberculosis death rate 68 per cent.

SMALLPOX

Causal Agent.—Unknown.

Source of the Causal Agent.—Discharges of the nose and mouth contain the virus which is received from the discharges from the lesions of the lining membranes in the nasal passages and mouth. Also the discharges of the lesions of the skin contain the virus.

Exit of Causal Agent from the body of the patient is probably most by way of nasal and mouth discharges; but also by discharges and scales of skin.

Entrance of Causal Agent is gained usually by breathing of droplets from nose or mouth of patient.

Agents of Transmission.—Droplets of nose and mouth of patient are the most active agents in the spread; articles soiled with discharges of lesions of mouth or skin. The virus may also be in urine or feces.

Incubation Period.—Eight to 21 days.

Period of Communicability.—From first symptoms to disappearance of all scabs.

Exclusion from School.—Patient to be excluded till disappearance of all rash and till he has been thoroughly soaped in bath, including scalp. Mouth and nose should be disinfected with gargle and spray. Exclude contacts from 7th to 22d day after exposure, or for 7 days after successful vaccination.

Early Symptoms.—Onset is rather sudden usually. Feverishness, severe headache and sickness attend. About 3d day a red rash appears, first on the face and wrists.

Measures for Prevention.—(*a*) *Measures Concerning the Patient and His Environment.*—(1) Isolation and quarantine. (2) Vaccination of attendants and exposed persons, and daily medical inspection of such contacts. (3) Concurrent disinfection of all discharges. No article to leave the patient's surroundings without boiling in water or otherwise

being disinfected. (4) Terminal disinfection—thorough washing of floors and furniture with 5 per cent carbolic acid solution, or 10 per cent formalin solution, or 1 : 1,000 solution of bichloride of mercury. Scrub floors with hot water and soap. Re-paper all walls. Air and sun the room or house for a few days.

(*b*) *Public Measures for Prevention.*—Vaccination of all infants; re-vaccination of all children on entrance to school; vaccination of all the population in localities where outbreaks occur.

Incidence.—Smallpox was once as common as measles now is. During the 18th century about 60,000,000 people in Europe died of this disease. The Indians had never known smallpox till it was brought to them by the Spaniards soon after the discovery of America. It is estimated that there were about 12,000,000 Indians in the Western Hemisphere at that time and that 6,000,000 died of smallpox. In the United States we have an average of about 50,000 to 60,000 cases per year, but it is very rare that a case occurs among persons vaccinated.

Compulsory Vaccination in Germany.—In the large German army, where all soldiers were vaccinated, there were only two smallpox deaths from 1874 to the time of the World War (1914). Compulsory vaccination was had in the civilian population, too. In the years 1901–10 there were 380 deaths from smallpox in the civilian population of Germany while in England and Wales, which had only one-half the population of Germany but where no compulsory vaccination prevailed, there were 4286 deaths. On the average in recent years Germany has only 200 to 300 cases of smallpox, a sharp contrast to the condition in the United States where no compulsory vaccination prevails and where 50,000 to 60,000 cases occur annually. It should be added that about one-half of Germany's cases are among foreigners visiting there.

Discovery of the Smallpox Vaccine.—The word "vaccine" is derived from a Latin term meaning cow ("vacca"). Edward Jenner, an English physicain, learned that there was a tradition among the country folk of a certain section of England that if one had had cowpox he could not take smallpox. It was claimed by the country folk that if one got the variolous matter from the pustule of a cow that had cowpox into a sore while milking, for instance, that such person would be immune to the dreaded smallpox, which was then taking a half-million lives each year in Europe. Jenner experimented. In 1796 he transferred the vaccine matter from a milkmaid's hand which had been scratched by a thorn and subsequently inoculated by cowpox, to the arm of an eight-year old boy. What we now know to be a typical *take* followed. Two months later Jenner inoculated the same boy with variolous matter

taken from a smallpox patient. (This had been the regular method of inoculation or vaccination before Jenner's time. This method produced smallpox, but milder than when received in the natural way.) But the boy showed no symptoms of smallpox. He was immune to the greatest scourge of the human race! Jenner later experimented with 10 other volunteers with perfect results. He then read the results of his experiments before a meeting of medical men in London and his paper was published to the scientific world. Jenner's work was of great historical significance: (1) It sealed the doom of one of the greatest enemies of man. (2) It was the first vaccine devised; it was the first of the several highly efficient methods for artificial immunization which we now possess; it was the practical beginning of modern immunology, which holds such remarkable promise for the future of the race.

How Smallpox Vaccine is Made.—A young cow or calf which is known by a highly trained, scientific veterinarian to have been isolated from other cattle and in perfect health, is inoculated with smallpox virus, from the pustules of a patient. Or the calf may be inoculated from another animal which already has the *cowpox*, as smallpox is known in the cow. When the skin eruption appears on the calf the variolous matter is taken from the pustules, purified by killing of the foreign bacteria which might be present, and put up in glycerine in small tubules of glass. This comprises the smallpox vaccine.

Are Cowpox and Smallpox the Same?—It is believed that the germ, whatever the germ may be, is the same, producing the same disease in man and the animal. Now, it is commonly known to bacteriologists that certain disease germs are *attenuated* or injured or have their virulence reduced by being injected into certain animals. In other words, such germs passed through an animal in that way do not produce disease so readily and strongly as before. It is believed that when the smallpox virus is taken into the body of the calf it finds there a rather unfavorable environment which reduces its virulence permanently. When the virus is taken from the skin pustules of the calf and transferred back to man a mild case of smallpox is had, which, however, is sufficient to immunize against smallpox contracted in the usual manner.

VENTILATION AND HEATING IN RELATION TO THE DROPLET-DISSEMINATED INFECTIONS

Since the avoidance of some of the infectious diseases, especially the respiratory diseases treated in this chapter, depends so much upon the capacity of the body to resist the causal agents of those diseases, and since the degree of resistance which the body may make depends much on the temperature and ventilation of the environment of the body, it is proper here to consider the problems of efficient ventilation and heating.

Factors of Good Ventilation.—*The primary object of ventilation is to promote heat loss from the body at a satisfactory rate.* There are three factors which constitute good ventilation: The first factor is **temperature.** The temperature of the living room or the school room should be 66 to 68 deg. F., not higher than 70 deg. as a maximum. School children in rooms at 69 deg. revealed 50 per cent more respiratory troubles than in rooms at 66 deg. It has been found by experiment that persons perform work more accurately and in larger quantity when the room temperature is 66 deg. than at higher temperatures. Typists did 6 per cent more work in a temperature of 68 deg. F. than in one of 75 deg.

The second factor contributing to ventilation is **humidity.** But when window ventilation is used in proper manner, to be described below, humidity need not give concern.

And the third factor in producing a comfortably ventilated room is the degree of **air motion.** Such air motion should be only slight, perhaps imperceptible to the skin. The air motion should be such as to cause only very slow and vacillating movement of a smoke made in a room, from a burning cloth, for instance.

These three factors promote loss of heat from the body and the dissemination of moisture from the skin, and these two end results are necessary for comfort and health. The heat jacket and the vapor jacket which immediately surround the body when the latter is motionless and the air is not stirring must be constantly dispelled if the body is to be maintained in a comfortable state and healthy condition. The slight air motion in the room or a cold atmosphere dissipates the two jackets and thus promotes heat loss with consequent comfort and health. The heat loss and dissemination of moisture are also necessary to the maintenance of a high capacity on the part of the body to resist germs of disease, for the resisting substances are not produced by the body efficiently, or they do not work effectively, while the body is in a depressed state or condition.

Theories With Regard to Cause of Body Depression.—(1) The *carbon dioxide theory* was suggested by Lavoisier during the 18th century. This great chemist had noted that the carbon dioxide content in a crowded room increased many times, about 10 times in the worst ventilated rooms. Lavoisier thought that carbon dioxide was far more poisonous than it is, but it is now known that the carbon dioxide content of a room must be increased about one hundred times before it produces discomfort. Such a high concentration of carbon dioxide is never produced, even in the most crowded rooms. Lavoisier's suggestion was a mere guess, as he himself indicated. Yet, his carbon dioxide theory in explanation of the discomfort felt in crowded and poorly ventilated rooms has persisted to this day and is found in text books, notwithstanding the fact that Lavoisier's theory was wholly disproved by experiment 60 or 70 years ago.

(2) The *emanating poisons theory* was suggested by Von Pettenkofer about 1863. Von Pettenkofer had shown by experiment that the excess carbon dioxide in a crowded and insufficiently ventilated room did not produce the discomfort and malaise. In the place of the carbon dioxide theory he proposed the suggestion that the malaise was possibly due to unknown organic poisons emanated from the body and which were then breathed.

(3) The modern *thermal theory* to explain the cause of discomfort and headaches experienced in rooms insufficiently ventilated and crowded was established in the early years of the 20th Century. In 1905 Flugge and his students performed a series of ingenious experiments which resulted in the formulation of the thermal theory. Flugge and his pupils shut persons in a small cabinet for periods of 4 hours each. The carbon dioxide content rose high, but so long as the cabinet was kept cool and the humidity kept low, no ill effects were felt by the subjects of the experiment. Flugge thus disproved the carbon dioxide theory, as had Von Pettenkofer before him.

In another experiment made by one of Flugge's students, a man was put into a small cabinet at 75 deg. F. The humidity was high and the carbon dioxide content was high. Persons outside the cabinet who were breathing the cabinet air through a tube felt no discomfort, but the subject inside the cabinet soon showed signs of distress. Then the subject was allowed to breathe the outside air through a tube, but he obtained no relief. When the cabinet temperature was reduced to 63 deg. F., or when an electric fan inside was started, the subject was relieved immediately. This experiment showed that it was not the air breathed nor any of its content or lack of content that produced discomfort and

depression. It disproved both the carbon dioxide and emanating poisons theories. It proved the modern thermal theory, that the vapor zone and heat zone immediately about the body produce the discomfort. Those two zones prevent sufficient loss of body heat. *The thermal theory is that heat loss from the body must take place at a certain rate if the body is to feel the sense of comfort, experience the highest state of health, and maintain the highest degree of resistance to organisms which produce disease.* In order that the heat loss may take place sufficiently, the heat and vapor zones must be dissipated at certain rates.

Summary of the Objects in Ventilation.—The body is generating heat constantly, the heat being released from the oxidation of food in the individual cells of the body. The heat constantly being produced in the body must pass off from the body; it must not accumulate within the body nor in its immediate surrounding atmosphere. So long as the heat loss from the body takes place at a certain rate, no unfavorable symptoms occur. But if the heat loss does not take place with sufficient rapidity, the untoward symptoms do occur. Heat loss at a certain rate is the primary object in ventilation.

The secondary objects of ventilation are: (1) to keep the moisture content of the air moderate, and (2) to maintain a certain temperature of the body's immediately surrounding atmosphere. Motion of the air or admittance of cool air through the window aid in accomplishing the two secondary objects. *The two secondary objects are sought for the purpose of attaining the primary object in ventilation.* And, to repeat, *the primary object in ventilation is to promote heat loss from the body at a favorable rate.* Question: In winter is it necessary to raise the windows of a sleeping room whose temperature is already down to freezing point, let us say, and in which there is no source of heat? Is "fresh air" a good term for use?

Ventilating the Bedroom.—The bedroom in warm weather should have entrance and exit of air to such degree that smoke, if made over the bed, would float very slowly, almost imperceptibly, about the room. The closed room with no ventilation in warm weather and the room ventilated with heavy drafts of air are extremes and not to be tolerated. The bedroom should be cold, perhaps 30 to 50 deg. in winter being the most desirable temperature. If the bedroom be very cold, heat loss from the body will be sufficient and the entrance of "fresh" air into the room and air motion in the room will be unnecessary. In this connection refer to Flugge's experiments described above.

Ventilating the Living Room.—The living room may be satisfactorily ventilated by windows. A narrow board three or four inches wide may

be laid upon edge beneath the lower sash of a window so that outside air may enter the room between the sashes. This together with opening of doors while passing in and out is sufficient ventilation for cold weather. The temperature of the room, as indicated above, should be maintained at about 66 to 68 deg. F. Temperatures above 68, or 70 deg. as maximum, tend to reduce the body capacity for either mental or physical work. Such temperatures also reduce the body's capacity for resistance to disease-producing organisms, and "colds," or other respiratory disturbances, are likely to result. The humidity of the living room will not be a problem to consider if the room is ventilated properly by means of windows.

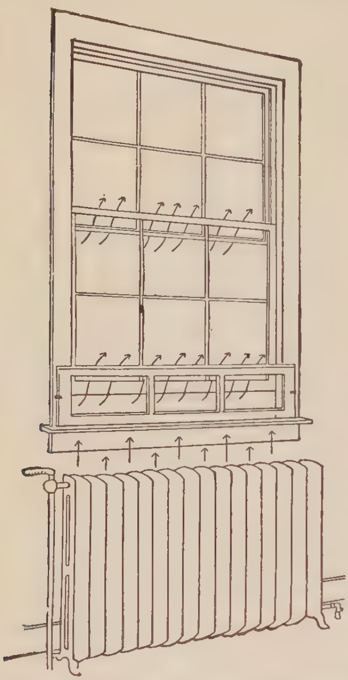


Fig. 23.—Fairfield system of window ventilation. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton & Co.)

Ventilating the Work Room.—The work room may be ventilated after the same manner suggested for living rooms. The temperature most desirable for the work room depends upon the amount of physical activity involved in the work. For some types of work, temperatures below 66 deg. F. are desirable.

Ventilating the School Room.—The temperature of the school room should be the same as that of the living room. The recent exhaustive investigations of the New York State Commission on Ventilation revealed some extremely interesting facts relating to ventilation of school rooms, not including school auditoriums. This Commission recommends the use of the window-supply gravity exhaust system (Fig. 23) of ventilation for rooms seating fewer than 100 pupils, rather than the use of the fan system for ventilation. The window-supply gravity exhaust system consists of windows with wide, slanting boards attached inside the windows and at the bottom to deflect incoming air upward into the room, and of vents or flues for receiving the outgoing air forced upward by the gravitation of the colder and heavier air from outside. The fan system is recommended to be continued for ventilating auditoriums seating more than 100 students.

Some of the definite findings of the New York Commission might be stated:

The Commission found that the most desirable temperature for rooms where pupils remain seated to be 66 to 68 deg. F. At this temperature the degree of humidity in a window-ventilated room is never far from the ideal and need not greatly concern the teacher or school official. At the range of temperature mentioned pupils experience less respiratory disease than at higher and lower temperatures.

The Commission also found that the most satisfactory and most comfortable air motion was the slight, non-uniform, intermittent air motion such as takes place through an open window with a deflecting board and no direct breeze striking the pupils.

Another finding was that the fan-ventilated rooms showed 18 per cent more absences among pupils due to respiratory illness ("colds," influenza, etc.), than did the window-gravity exhaust rooms. The fan-ventilated rooms furthermore showed 70 per cent more respiratory disease among the children who continued in attendance.

The findings of the New York Commission have been verified by two separate investigations made more recently.

Effects of Extreme Heat or Cold on the Body.—If the body is subjected to extremes of heat or cold, the capacity of its immune substances for resisting invading bacteria or their harmful products is reduced. The principle is easily illustrated with animal experiments. For instance, the hen is ordinarily immune to the germ of anthrax (charbon) when injected with the bacilli. But if the hen is injected with the germs, then put into an ice box and made to stand in cold water, she contracts anthrax and succumbs to it. Again, the frog is immune to anthrax under ordinary conditions of environment. But if the frog is injected with anthrax bacilli and is then put in the warm atmosphere of an incubator, the animal takes the disease and dies. In the cases of the animals mentioned, their capacity for resisting the anthrax bacilli was lowered by the exposure to high and low temperatures. And it is just so with the human body. Subjection of the human body to excessive loss of body heat, as in becoming wet and cold, is more likely to be attended by "colds," influenza, pneumonia, etc. The same diseases are likely to overtake the body kept in a room of high temperature and dry atmosphere during the winter. Abnormal temperatures reduce the body's capacity to resist.

Methods of Heating.—*The Home:* Perhaps the most convenient method of heating the home is by means of gas stoves. But gas as a method of heating has decided disadvantages, especially if no vent or

outlet is provided above the stove. Burning gas may allow the escape of gases into the room which produce undesirable odors and headaches. Furthermore, there is always the possibility of danger from gas escaping from defective gas pipes, or defective stoves. For this reason it is especially hazardous to maintain a gas stove in a bedroom.

Hot air is a good method for heating the home, in case an efficient supply of moisture is provided with the dry hot air in some approved manner. The moisture or humidity can not be admitted from without for the hot-air system frequently does not work well with windows of the house open. But the hot-air system has the further disadvantage that the rooms on the windward side of the house are not so well heated by this system as are those on the opposite side of the dwelling.

Perhaps a hot-water system and radiators constitute a more desirable method than hot air for heating the home. With this system, window ventilation can be used to supply "fresh air" and humidity.

Wood or coal stoves have been much used for heating homes and are quite satisfactory. Some ventilation from windows should be had.

The fireplace and chimney is an old method of heating the home and one of the most satisfactory. The fireplace not only heats the room but it also produces a heavy draft of air up the chimney and this escaping air is replaced in the room by air from the outside.

The School and Places of Assembly.—The hot-air system is much used for schools and places of assembly. But hot air for heating and ventilating has rather serious disadvantages, mentioned above. Perhaps the hot water and radiator method is the best for public buildings of these types. The jacketed stove is good in the small school.

Summary.—We may say that the body's capacity for resisting disease-producing microorganisms and its capacity for work and for useful and joyous living may be enhanced by: (1) A wholesome, well-balanced diet; (2) seven to eight hours' sleep at regular hours every day; (3) rest and recreation out-of-doors and in sunshine. The favorable effects of the out-of-doors is not so much due to the *freshness* of the air as it is to the direct effects of the sunshine upon the body; (4) properly heated and ventilated rooms, both day and night; (5) use of vaccines and serums to immunize, especially for smallpox, typhoid, scarlet fever and diphtheria in the case of children and for the first two named in case of adults; and (6) practicing assiduously for the maintenance of upright mind and emotional balance.

The daily practice of such wholesome living as outlined above can not but greatly enhance one's chance of success in life. To live otherwise reduces proportionally one's chance for success.

OPTIONAL STUDIES

Whooping-Cough

Causal Agent.—*Bacillus pertussis.*

Source of Causal Agent.—Discharges from the lining membranes of the larynx and bronchial tubes of the lungs. Also, discharges of those lining membranes of infected dogs and cats.

Exit of Causal Agent.—By means of droplets.

Entrance of Causal Agent is gained by breathing of droplets from infected person or animal, or by close contact with articles freshly soiled with the discharges.

Agents of Transmission.—Droplets and freshly soiled articles from infected persons or animals.

Incubation Period.—Usually about 7 days.

Period of Communicability.—The disease is especially communicable in the early stages and before the appearance of the whoop. Some believe that it is communicable as long as 3 weeks before the whoop. It is also regarded that the communicability continues for some 3 or 4 weeks after the appearance of the whoop.

Exclusion from School.—The patient should be excluded from school for 5 weeks after the date of the first "whoop." Those exposed to whooping-cough should be excluded for 18 days if no "whoop" develops.

Early Symptoms of Whooping-Cough.—This disease begins as if it were a "cold in the head," with bronchitis, sore throat and a cough which is worse at night. Symptoms may be very mild in the early stage. The "whoop" begins about 14 days after onset.

Measures for Prevention.—(*a*) *Measures Concerning the Patient and His Environment.*—(1) Modified isolation of the patient and exclusion from school. (2) Vaccination of those who are known to have been exposed is not very effective in prevention. (3) Concurrent disinfection of discharges from the nose and throat of the patient and of articles soiled with such discharges.

(*b*) *Public Measures of Prevention.*—These should include education of the populace to the dangers of whooping-cough which frequently are not realized.

Incidence.—Whooping-cough occurs chiefly in the spring and summer and is more prevalent in rural communities than in cities, which facts are puzzling and cannot be accounted for. About 80 per cent of cases of whooping-cough occur in children under 5 years of age, and something like 75 per cent of the deaths occurring are among children under 2 years of age. There are about 10,000 deaths annually in the United States. Many deaths are charged to pneumonia which began as cases of whooping-cough, for whooping-cough reduces the resisting power of the body against pneumonia, and the latter frequently develops as a consequence. This is one of the more serious of the so-called children's diseases. The younger the child the more serious is whooping-cough likely to be. Twice as many deaths occur from whooping-cough as from scarlet fever. Having whooping-cough usually confers permanent immunity to the disease.

Chicken Pox

Causal Agent.—Unknown.

Source of Causal Agent.—The causal agent is present in the lesions of the skin and of the mucous membranes of the nose, mouth and throat. The lesions appear early in the mouth and rupture as soon as they appear, thus rendering the disease communicable early, that is, before the eruption appears on the skin.

Mode of Transmission.—By droplets directly from person to person, or indirectly by articles freshly soiled by discharges of the nose and mouth of a patient.

Incubation Period.—Two to three weeks.

Period of Communicability.—From time of appearance of lesions on mucous membranes till scabs have disappeared from the mucous membranes and skin.

Early Symptoms.—Sometimes begins with fever, but usually very mild with no fever. Rash appears about the second day as small pimples which contain a clear fluid that later becomes yellowish.

Exclusion from School.—Patient should be excluded until all scabs are shed. Any other child of patient's family should be excluded till about 22d day after seeing the patient last. Children exposed at school should be excluded from the 11th day after first exposure till 22d day after last exposure.

Methods of Prevention and Control.—(1) Isolation of patient. (2) Concurrent disinfection of articles soiled by discharges from lesions. (3) Terminal disinfection by mopping room and furniture with 10 per cent formaldehyde solution, then scrubbing with water and soap.

Significance of Chicken Pox.—Chicken pox is very mild and rarely reveals any serious after-effects. Its chief significance is that it is quite often confused with smallpox, even by the most skilled physicians.

German Measles

Causal Agent.—Unknown.

Source of Causal Agent.—Secretions of mouth and nose of patient.

Mode of Transmission.—By droplets when in direct contact with patient or by indirect contact methods, such as articles freshly soiled with discharges of nose, mouth or throat of a patient.

Incubation Period.—From 14 to 21 days.

Period of Communicability.—For about 8 days from onset of disease.

Early Symptoms.—Onset sudden. Lymph glands back of ears swollen. Rash often is present from first onset symptoms. No "cold in head." Usually fever, sore throat, and inflamed eyes.

Exclusion from School.—Patient should be excluded until complete recovery, at least 10 days. Any other child in the family of the patient should be excluded until 21st day after last seeing the patient.

Methods of Control of the Disease.—(1) Isolation of patients from non-immune children. (2) Concurrent disinfection of discharges from nose and throat of patient and of articles soiled by such discharges. (3) Terminal disinfection by airing and cleaning of room and furniture with 10 per cent formaldehyde and with soap and water.

Significance of German Measles.—German measles itself is not a serious infection, but may be confused with scarlet fever in early stages, even by good physicians.

Measles

Causal Agent.—The causal agent is unknown, but recently some work has been done which indicates that the causal agent may be a short streptococcus, or a diplococcus.

Source of Causal Agent.—Secretions of nose and mouth of infected individuals. Carriers are not known.

Mode of Transmission.—Directly from person to person by inhaling of droplets from patient. Also by indirect contact and through articles that are freshly soiled with secretions of patient. This is the most readily communicable of all the infectious diseases. Scales of skin probably not infective.

Incubation Period.—About 10 days.

Period of Communicability.—From about 4 days before the appearance of the rash to about 5 days after the appearance of the rash. Because of the fact that the patient is infective for 4 days preceding symptoms, isolation is not so effective in preventing spread of measles as in the case of some other diseases.

Exclusion from School.—Patient should be excluded until recovery. Other children of the patient's family should not return to school until 18th day after last seeing the patient. Children exposed at school should be excluded until 18th day after exposure.

Early Symptoms.—Measles starts as a sort of " cold in the head " with feverishness, running nose, watery eyes, and sneezing. About the third day a rash appears, on the forehead and face first.

Measures for Prevention. (*a*) *Measures Concerning the Patient and His Environment.*—(1) Isolation and quarantine of patient. (2) Immunization of contacts by use of serum or whole blood from a recently recovered patient within five days after exposure of such contacts. This prevents the attack of exposed persons in a great majority of cases, but if the disease is not averted it is much modified and milder. (3) Exclusion of exposed school children and teachers from the school until 14 days after exposure. (4) Concurrent disinfection of all articles soiled with secretions of nose and throat. (5) Terminal disinfection; cleaning of furniture and floor of patient's room with approved disinfectant followed by thorough washing with soap and warm water.

(*b*) *Public Measures for Prevention.*—(1) Daily morning examination of children who are not excluded from school but who possibly were exposed to the disease.

Incidence.—Something like 10,000 deaths from measles occur in the United States each year. Pneumonia frequently sets up as a result of the lowering of the body's resistance by measles, and thus many deaths are recorded as due to pneumonia which in fact are indirectly due to measles. Measles is notable for destroying anti-substances for other diseases and thus leading to those diseases. Measles in epidemic proportions usually occurs during the cooler months. Most cases of measles occur at about 6 or 7 years of age. One attack of the disease usually immunizes.

Mumps

Causal Agent.—Unknown.

Source of Causal Agent.—Fluids of mouth and possibly of the nose.

Mode of Transmission.—By direct contact with infected person and by inhaling droplets from such person, or by contact with articles freshly soiled with discharges of the nose and throat of an infected person.

Incubation Period.—From 12 to 26 days, usually 18 days.

Period of Communicability.—Unknown, but it is believed to continue until the salivary glands return to normal size. Some have believed that patients have been known to remain capable of transmitting the disease for as long as 6 weeks after disappearance of symptoms, but if this be true it is of rare occurrence.

Exclusion from School.—The patient should not return to school until about a week after disappearance of swelling. Exclude "contacts" from about 12th day after exposure to 22d day. Children from the home of the patient should not return until 3 weeks after last seeing the patient.

Early Symptoms.—Onset may be sudden, beginning with sickness and fever. Pain may be about the angle of the jaw. The salivary glands become swollen and tender and the jaw stiff.

Measures for Prevention.—(*a*) *Measures Concerning the Patient and His Environment.* (1) Isolation of the patient as well as exclusion from school. (2) Concurrent disinfection of all articles soiled with discharge of nose or throat of patient.

(*b*) *Public Measures for Prevention.*—None.

Incidence.—Mumps occurs most between the ages of 5 and 15 years. In the male the causal agent frequently reaches the testicles and causes sterility of either or both testicles. This infection of the testicles occurs in about 25 per cent of cases among males. There are certain predisposing factors which encourage the infection of the testicles such as injury to the testicles by pressure, of clothing even. Walking about the room may cause infection of the testicles. Rest in bed is a preventive measure against infection of the testicles. Sterilization of the female by mumps is not unknown.

Epidemic Meningitis

Causal Agent and Nature of the Disease.—Meningitis may be produced by a number of organisms. The disease is caused by certain organisms which by way of the blood stream may enter the *meninges* or thin membranes which surround the spinal cord and brain. After such organisms have gained entrance to the meninges they cause an irritation which leads to the secretion of a large amount of fluid within the meninges and within the cord and brain. This excessive amount of fluid exerts a strong pressure and produces at least some of the symptoms of meningitis. Degeneration of the nerve tissues of the brain and spinal cord also occurs.

Bacillus tuberculosis and the pneumococcus are among those organisms which may enter the meninges and produce meningitis. But epidemics of meningitis are caused by the *Meningoccus*, which, then, is said to be the causal agent of the epidemic form of meningitis. It might be remarked that the term *meningitis* means "inflammation of the meninges." (The suffix "-itis" means *inflammation*. Consider the meaning of *appendicitis*.)

Source of Causal Agent.—Fluids of the nose and mouth of patients or carriers. Carriers are numerous in times of epidemics.

Mode of Transmission.—By direct contact with patients or carriers and inhalation of droplets from such persons. Also by indirect contact through articles freshly soiled with nasal and mouth discharges.

Incubation Period.—Two to 10 days, usually 7.

Period of Communicability.—During the course of the disease and until the meningococcus is no longer present in the mouth and nasal discharges of the patient,

or in those of the carrier. Carriers usually remain so only temporarily, during an epidemic and perhaps a month or two afterward.

Measures for Prevention.—(*a*) *Measures Concerning the Patient and His Environment.*—(1) Isolation of patients until 14 days after the onset of the disease. (2) Immunization by vaccine is in an experimental stage at present. Immunization by serum is not very successful. However, the serum is quite useful in treatment of cases. (3) Concurrent disinfection of discharges of the nose and mouth and of articles soiled by those discharges. (4) Terminal disinfection, cleaning of the patient's room with cloth moistened with an approved disinfectant followed by a thorough washing with soap and water.

(*b*) *Public Measures for Prevention.*—(1) Education of the populace as to the necessity of avoiding droplet contact. (2) Prevention of overcrowding and poor ventilation in public buildings, living quarters, street cars, etc. (3) Living and working under well-ventilated conditions. (4) Modified isolation of carriers.

Incidence.—Meningitis occurs both sporadically and in epidemics. As indicated, the epidemic meningitis only is considered here. The fatality rate is high, usually about 75 per cent of patients succumbing to the disease, when the treatment serum is not used. Use of serum in treatment reduces the mortality to about 35 per cent of cases. The epidemic form of meningitis occurs most in crowded conditions and is spread chiefly by carriers. It occurs mostly in the colder months of the year. Children and young adults are most susceptible. The disease is not highly communicable. It is quite irregular in its movement and frequently shows curious pranks in its sporadic occurrence, due to carriers, and to the further fact that it is not highly communicable.

Scarlet Fever

Causal Agent.—*Streptococcus scarlatinae.*

Source of Causal Agent.—Usually discharges from the nose and throat; but running ears or abscesses may be a source. Articles freshly soiled with such discharges may disseminate the causal agent. The nose and throat discharges of carriers also constitute a source.

Exit of Causal Agent.—The exit from the body of the patient or carrier is by droplets from the nose and mouth and by way of other discharges mentioned above.

Entrance of Causal Agent is by breathing of droplets or by intake of the causal organism from articles freshly soiled with discharges or from contaminated milk.

Agents of Transmission.—These are toys, towels, handkerchiefs, and other objects contaminated. Occasionally an epidemic of scarlet fever occurs due to contaminated milk. The milk may be contaminated by workers at the dairy who happen to be carriers or patients, or who happen to be nursing patients at the time. Scales from the desquamating skin of convalescents are not dangerous.

Incubation Period.—From 2 to 7 days, usually about 3 or 4.

Period of Communicability.—At least 3 weeks from the onset of the disease, and after all abnormal discharges have ceased and open sores healed.

Exclusion from School.—The patient should not return to school until after all symptoms have disappeared, which is usually as long as 30 days after onset. "Contacts" should be excluded until 7 days after last exposure.

Early Symptoms.—Onset usually is sudden, with headache, languor, feverishness, sore throat and often vomiting. The skin rash usually appears in 24 hours. It is a

very finely spotted and evenly diffused rash. It is bright red. The rash appears first on the neck and upper chest.

Measures for Prevention.—(*a*) *Measures Concerning the Patient and His Environment.*—(1) Isolation, quarantine. (2) Exposed individuals should be given the Dick test and those found to be susceptible should be actively immunized by scarlet fever toxin. The immunizing toxin is injected in 3 doses given subcutaneously at one-week intervals. Immunity is established about 2 weeks after the last " shot." (3) Concurrent disinfection of all articles which have been in contact with patient and all articles soiled with discharges of patient. Discharges from the nose, mouth, or abscesses caused by the organism should be collected on pieces of paper or rags and burned. Bed and body clothing and eating utensils should be boiled in water 10 minutes or longer. (4) Terminal disinfection by washing the floor and furniture of the room with disinfectants such as those described in connection with concurrent disinfection for typhoid. The use of the disinfectant should be followed by thorough cleansing with hot water and soap, and with sunning and airing of the room.

(*b*) *Public Measures for Prevention.*—(1) Daily examination of exposed children and others for one week after exposure. (2) Schools need not be closed if daily observations by physician or nurse can be had for the children. (3) In school, immunization of all exposed children with scarlet fever toxin is advisable in the cases of those children found by the Dick test to be susceptible. (4) Education of the populace as to the special danger of exposing little children to those who exhibit catarrhal symptoms of any kind. (5) Pasteurization of public milk supplies.

Incidence.—Scarlet fever is especially widespread in temperate climates. In our Southern States it is not so common as farther north. It is rare in tropics. There is about twice as much scarlet fever in the city as in the rural districts. Susceptibility to the disease reaches its height at about the sixth year of life. For three years afterward susceptibility falls rapidly. Scarlet fever reaches its greatest incidence in January to March. The virulence of scarlet fever is declining. During the last fifty years the mortality has declined from an average of 40 per 100,000 population to 2 per 100,000. This decline in the virulence of scarlet fever can not be explained.

Historical Note.—The scientific conquest of scarlet fever has been effected only recently. This conquest of one of the most dreaded diseases of childhood is due chiefly to the work of Dr. George Dick and Dr. Gladys Dick, husband and wife, of Chicago. By inoculating volunteers they demonstrated that scarlet fever is due to a streptococcus. They also showed that this streptococcus usually remains on the surface membranes of the throat and rarely enters the tissues or blood stream. They revealed that scarlet fever symptoms are caused by a soluble exotoxin, which is produced within the bodies of the bacteria and extruded through their body surfaces and then absorbed by the tissues and blood stream of the human body. The Dicks obtained this toxin by growing the streptococci in broth, then filtering the broth through unglazed porcelain filters in order to get rid of the streptococci themselves. The filtered broth contained the toxin. The Dicks then injected small portions of this toxin into volunteers and produced the symptoms of scarlet fever. By repeated injections with small amounts of the toxin, 5 successive injections one week apart, they immunized persons susceptible to scarlet fever. The Dicks also developed a skin test for susceptibility to the disease, which is now called the Dick test and which is made in a manner similar to that of the Schick test for diphtheria susceptibility. Finally, an antitoxin was produced by repeated injections of toxin into a horse. This antitoxin possesses high curative value, due to its combining with toxin to pro-

duce a harmless compound. But the antitoxin has little or no effect upon the streptococci themselves. Thus, we now know the causal agent of scarlet fever; have a practical test for susceptibility; now possess a toxin for producing active immunity in persons who are susceptible to the disease; and have an antitoxin which possesses high curative value.

Comparison of Scarlet Fever and Diphtheria.—These two diseases are very distinct and separate infections. Yet they are remarkably alike in certain phases: (1) Both diseases are due to bacteria which usually remain on the inner surfaces of the throat and which rarely enter the tissues or blood stream. (2) In each is produced a soluble exotoxin which enters the blood stream and the tissues and which produces the toxic symptoms of the disease. (3) The toxin of each of the two organisms may be developed in broth and used in the skin test for susceptibility of the disease. (4) The toxins may be used also in producing active immunity. (5) The toxins furthermore are injected into the bodies of horses to produce antitoxin. (6) The antitoxins produced in the blood of horses are used in the treatment of the respective diseases.

Trachoma

Causal Agent.—Recently reported by Dr. Noguchi to be a small bacillus. The bacillus appeared to produce trachoma when inoculated into the eyes of monkeys.

Source of Infection.—Secretions and discharges from the conjunctivae (the lining membranes of the eyelids).

Mode of Transmission.—By direct contact with infected persons and indirectly by contact with articles freshly soiled with the infective discharges of such persons, such as handkerchiefs, towels and wash basins used in common.

Incubation Period.—Undetermined.

Period of Communicability.—During the persistence of lesions of the conjunctivae or of discharges from such lesions.

Methods of Control.—(*a*) *The Infected Indvidual and His Environment.*—(1) Isolation; exclusion of the patient from school. (2) Concurrent disinfection of discharges of eyes and articles soiled therewith.

(*b*) *General Measures.*—(1) Search for cases by examination of school children. (2) Elimination of common towels and toilet articles from public places. (3) Education in the principles of personal cleanliness and the necessity of avoiding direct or indirect transference of body discharges.

Importance and Distribution.—Trachoma is a very serious eye affection. If not treated it impairs vision for life. Tiny granules, which are small cream-colored stone-like bodies just beneath the conjunctivae of the eyelids, cause scratching and irritation of the eyeball. Trachoma in our country is found most among the Indians and among the people of our Southern States, especially among those of the Southern mountain areas. The disease is sometimes known as "granulated" eyelids.

SUMMARY STATEMENT

The group of infections considered in this chapter are usually disseminated by droplets, or by articles freshly soiled by them, from the nose and mouth of the patient or carriers. But there are some which

may be occasionally disseminated by other methods, smallpox for instance.

Some of the diseases of this group are preventable to a very high degree, such as smallpox, tuberculosis, diphtheria, scarlet fever and trachoma. Others are not preventable to so high a degree, under the present state of knowledge. Some of these are still the greatest scourges of the human race, but each is being attacked vigorously by research scientists in every civilized country. Which of the diseases included in this chapter was most recently conquered, scientifically speaking?

The basic principle of prevention for this group is avoidance of droplets of patients and carriers. Yet this is not altogether practicable in our modern complex society, even in times of epidemics.

Secondary measures for prevention and control are artificial immunization by vaccines and serums, in cases of some of these infections; sterilization of articles freshly soiled with discharges of the nose and mouth of patients and known carriers; complete or modified isolation of patients; pasteurization of milk; and proper heating and correct ventilation, as defined in this chapter.

Recent investigations made in house to house canvasses have shown that more than one-half of illness in modern life consists of the respiratory diseases.

CHAPTER IV

DISEASES DISSEMINATED BY INSECTS AND HOW TO AVOID THEM

For 2000 years men had suggested that mosquitoes and certain other insects might disseminate human diseases. In 1893 the eminent American bacteriologist, Theobald Smith, showed that the causal agent of Texas fever in cattle was transmitted from one animal to another by a certain species of tick. This discovery is of great historical importance in the history of preventive science, for it was the first time that a disease was definitely shown to be transmitted by an insect. Theobald Smith's discovery gave an impetus to the idea that diseases of man might be carried from person to person by insects.

Since that discovery it has been found that a number of diseases of man are transmitted by insects. All blood-sucking insects should be regarded with suspicion, for, even though they do not regularly transmit a certain specific disease, they may in a mechanical way inject into the blood the germs of erysipelas; or streptococci, which produce blood poisoning; or the *Bacillus tetanus* of lockjaw, etc.

There are two general methods of transmitting causal agents of disease by insects:

(1) *Biological* transmission is that method of transmission in which the causal agent of the disease in question passes through a cycle of development while in the body of the insect which transmits it. The causal agent can not be transmitted by the insect to the human body so as to produce disease until after such causal agent has passed through its cycle of development within the insect host. Causal agents which pass through such cycles of development in the body of the insect are protozoan parasites of the human body. Examples of biological transmission: those of malaria and yellow fever.

(2) *Mechanical* transmission is that type of transmission in which the causal agent is transferred in a purely mechanical way to the blood stream of man. The causal agent which is transmitted mechanically may be upon the mouth parts of the insect, or even within the insect's intestinal tract; but it does not pass through a cycle of development, it

remaining in one form or condition of body and life. Most of the causal agents of diseases which are transmitted mechanically are bacteria. Examples of mechanical transmission are: the typhoid bacillus when carried on the feet or within the intestinal tract of the housefly; the tetanus or lockjaw bacillus, which may be inserted into the skin by the bite of an insect; and the bubonic plague bacillus, which is carried by fleas from infected rats to man.

To prevent insect-borne diseases one must know thoroughly the disease itself, the details of the life history of the parasite or causal agent, and the exact life history of the insect which transmits. Insect-borne diseases are controlled by attacking the insect in its most vulnerable stage of existence, or by striking at the parasite at its weakest stage of development, or both. As an illustration let us take malaria. The causal agent is best attacked with quinine at a time of its cycle when it is not within the red blood corpuscle, but when it is in the open blood-stream. The mosquito, which is the vector of malaria, is most easily attacked and destroyed while in the larval and pupal stages of development.

MALARIA

Causal Agent.—Three different species of *Plasmodium*, which is a protozoan and which is a member of the sub-group, Sporozoa.

Source of Causal Agent.—The blood of an infected person, either patient or carrier.

Exit of Causal Agent.—From the body of an infected person by being sucked into the body of a female *Anopheles* mosquito.

Entrance of Causal Agent.—The entrance into the body of a potential patient is effected by being injected into the blood stream by female *Anopheles* at least 10 days after the mosquito's having received the infection. The ten days is necessary because the causal agent must pass through its cycle of development in the body of the mosquito before it becomes infective for man.

Agent of Transmission.—This is the female *Anopheles* mosquito. The male *Anopheles* does not suck blood for food; it lives upon the nectar of flowers.

Incubation Period is usually about 14 days in the case of the species of Plasmodium (*P. vivax*) which causes most malaria in our Southern States.

Period of Communicability is as long as the organism exists in the body of the patient or carrier. A person may be a carrier for several years.

Measures for Prevention.—*(a) Measures Concerning the Infected Individual and His Environment.*—(1) Modified isolation, that is, screening of the room of the patient or carrier from the rest of the house until bacteriological examination of his blood no longer shows malarial parasites present. (2) Administration of quinine regularly to those of the family and attendants who may be exposed to mosquitoes infected by the patient. The quinine so administered kills any Plasmodia which may reach the blood stream. (3) Disinfection, none. But all mosquitoes found in the sick room should be destroyed.

(b) *Public Measures for Prevention.*—(1) The destruction of larvae of anophelines and destruction of breeding places of such mosquitoes by methods to be described later. (2) Screening of houses with screens of 16 to 20 strands of wire per inch. (3) Killing of the mosquitoes in houses by means of insecticides or by other methods.

Chief Symptoms of malaria are paroxysms of intermittent fever, marked anemia and debility, and enlarged spleen.

Incidence of Malaria.—Malaria is confined mostly to the tropics and subtropics. As a single disease it is the greatest scourge of the warmer regions of the earth. Ross estimated that in India alone more than 1,000,000 persons died each year of malaria. In the United States the disease is not so highly fatal as in India, due in part to the fact that the disease in the two countries is caused mostly by different species of the Plasmodium—the species causing most of the malaria in the United States is not so virulent as that which is most prevalent in India. According to Professor Chandler, other factors of high mortality in India are lack of advancement in sanitary measures and the poor state of nutrition of the people. There are only some 12,000 deaths annually in our Southern States, but malaria is very widespread in the South, there being probably a half million to a million cases of the disease each year. In contrast, ten years ago there were probably as many as 3,000,000 cases annually in the South. In the year 1917 it was estimated by the State Board of Health of Texas that there were 500,000 cases in Texas alone that year, but at the present there are 1,000,000 persons in Texas who live in mosquito-protected territory. The decline of malaria in the South has been rapid.

Malaria attacks children and young persons mostly. After repeated attacks most persons become tolerant to the parasite and reveal less pronounced symptoms even though infected. After disappearance of symptoms of malaria, the malarial parasite may remain in the tissues of the body for a number of years. There are many thousands of such carriers in the Southern States. The carriers constitute one of the

important obstacles in the eradication of the disease. It is estimated by some that in certain communities as high as 70 per cent of the population are carriers who may infect mosquitoes and thus prepare the way for the infection of other persons.

Popular Myths Regarding the Source of Malaria.—In the first place it might be said that many people have a very indefinite and vague notion as to what malaria is. Persons, for instance, frequently are heard to say that they are suffering from malaria when, in fact, it is a disturbance of the digestive tract. Many people think that the malarial organism lives in stagnant ponds from which the mosquito comes after being hatched and after spending its larval life in the water. That is not the case. The malarial germ cannot live in water. The Plasmodium is not present in the body of the mosquito until after the mosquito has sucked the blood of a malarial patient or carrier. Some have thought that they got malaria from eating fish caught in stagnant ponds; or from drinking bad water; or by eating watermelons that were rotten at one end; or from air passing over ponds that were covered with scum or that were drying up; or from "night air." The malarial parasite lives only in the human body and in the body of a mosquito, positively in no other situation. The only possible source from which malaria may come to the human body is from the body of an infected female *Anopheles* mosquito.

Life Cycle of the Malaria Parasite.—The life cycle, or the life history, of the malaria parasite is one of the most remarkable phenomena in the biological world (Fig. 24). The malarial germ is injected from the salivary glands of the infected female *Anopheles* mosquito into the blood stream of the human being when the blood is sucked by the mosquito. As the mosquito draws the blood it mixes with the blood a chemical substance formed by the salivary glands; this substance is to prevent the coagulation of the blood after reaching the mosquito's stomach. In this mixing process the malarial parasite passes down through the proboscis of the mosquito into the blood stream of the person. After reaching the blood stream the parasite attaches itself to a red blood corpuscle and burrows its way into the corpuscle. Within the corpuscle the parasite grows, increasing its size many times until it comes to fill most of the inner part of the corpuscle. The parasite's body then divides and re-divides to form several young parasites (Fig. 25). When the young parasites have reached a certain stage of maturity the corpuscle, which is no longer anything more than a shell of its former self, disintegrates, thus releasing the young generation of parasites into the open blood stream. The young parasites are known as *merozoits*. The

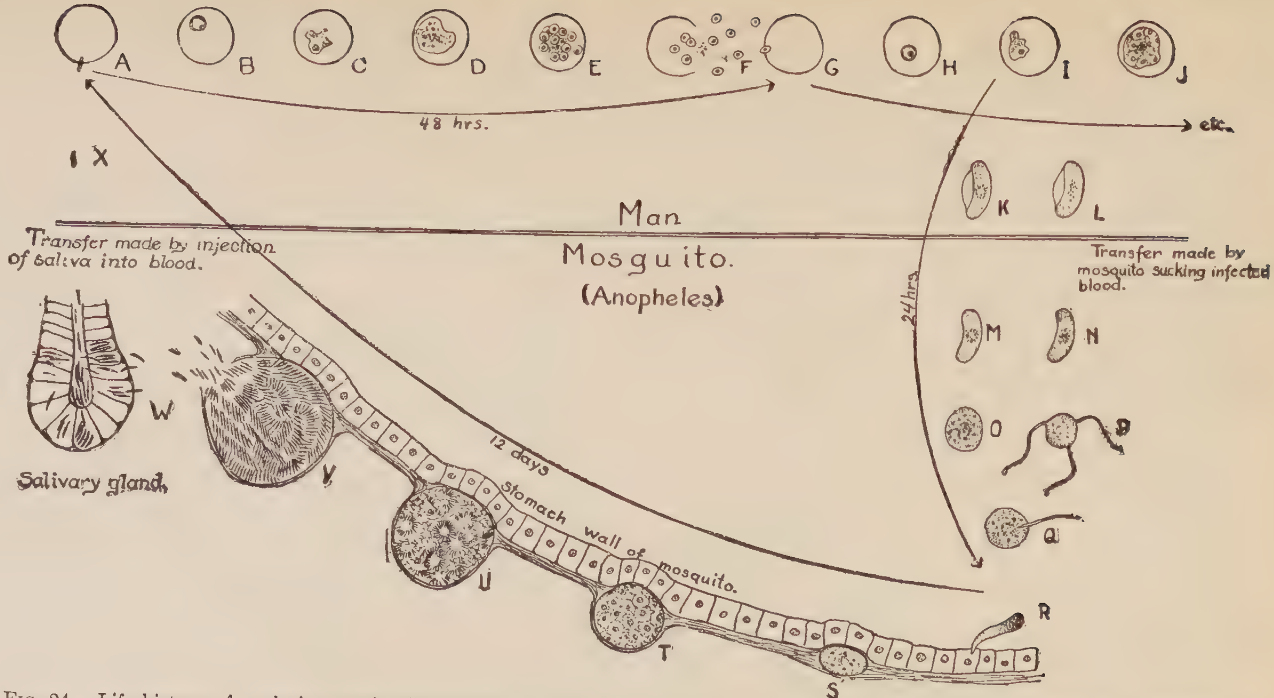


FIG. 24.—Life history of malaria parasite (*Plasmodium falciparum*); *A*, spore from salivary gland of mosquito entering red blood corpuscle; *B*, young "ring" stage; *C*, later ameboid stage; *D*, adult parasite ready to sporulate; *E*, young parasites in corpuscle, resulting from sporulation; *F*, *G*, liberation of young parasites and attack of new corpuscle; *H*, *I*, and *J*, repetition of growth, sporulation, etc.; *K* and *L*, female and male cells (gametocytes) respectively, in blood stream; *M* and *N*, same, in stomach of mosquito, remnants of blood corpuscles digested off; *O*, mature female gamete; *P*, formation of "flagellated body," *i.e.*, extrusion of male gametes from male gametocyte; *Q*, fertilization; *R*, young wormlike body, developed from fertilized egg, penetrating wall of mosquito's stomach; *S*, *T* and *U*, stages in development of spore-filled capsule on outer wall of mosquito's stomach; V, mature capsule bursted, liberating spores into body cavity; *W*, penetrating of spores into salivary glands; *X*, injection of spore into human blood. *A–Q*, x 1000, *R–X*, x 500. (Suggestions from various authors.) (Reprinted by permission from "Animal Parasites and Human Disease," by Chandler, published by John Wiley & Sons, Inc.)

merozoits released in the blood stream at once attach themselves to red blood corpuscles, burrow into them, and each divides and re-divides to produce about 12 to 20 progeny. This second generation of merozoits is also released into the blood stream by the disintegration of the corpuscles, and each attacks a fresh corpuscle. The process of attacking corpuscles and multiplication of the parasites continues until there are many millions of parasites and parasitized corpuscles in the blood of a single infected person. Up to this time the parasites are all alike, no distinction in sex. But some of the parasites may now become male and others female. In this stage of development they are ready for the mosquito to receive them into her stomach.

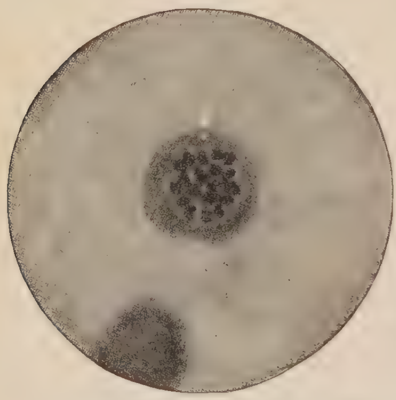


Fig. 25.—The malarial parasite within a red blood corpuscle, magnified 1800 times. It will be noted that the parasite has divided to form several young parasites, *merozoits*. (From Jordan's "General Bacteriology," published by W. B. Saunders Co.)

Within the open stomach of the mosquito the female germs are fertilized by arm-like processes which break off from the bodies of the male germs. The fertilized female organism assumes a spindle-shaped form and burrows into the wall of the mosquito's stomach. There its body grows and divides and re-divides to produce a large number of spore-like young organisms. This large group of young organisms causes the development of a sort of ulcer on the outer wall of the mosquito's stomach. When the young *sporozoits*, as they are called, have reached a certain stage of maturity the ulcer ruptures and the sporozoits are thus discharged into the abdominal cavity which surrounds the mosquito's stomach. The sporozoits find their way to the salivary gland of the mosquito by way of the lymph spaces and blood of the mosquito. The sporozoits now are ready to be injected into the blood stream of any person whose blood the mosquito may happen to feed upon. It requires from 10 to 15 days usually for the parasites to pass through the various stages of development which take place in the body of the mosquito.

The Cause of the " Chill " and Fever.—Frequently in the Southern States malaria is known as " chills and fever." But what causes the " chill " ? After the infected person has had his infection for several days there are many millions of red blood corpuscles parasitized by the

Plasmodia. Now, the parasitized corpuscles all disintegrate at about the same hour of the day and release the merozoits. At the time of the disintegration of the corpuscles it is believed that toxin is also released, the toxin having been formed by the parasites while still within the corpuscles. The toxin released from within many millions of corpuscles at approximately the same hour of the day, poisons the body tissues and causes the rigor known as the " chill." The chill is followed by fever, which lasts for several hours. We have mentioned previously that there are three species of Plasmodium. Two of the species cause the red corpuscles to disintegrate and release their merozoits and toxin regularly once in 48 hours. Thus, in the cases of malaria produced by either of these two species there is a chill every 48 hours. The third species of Plasmodium causes a chill at very irregular intervals. The patient may have a double infection, received from mosquitoes on two successive days or otherwise, so that a chill may be had every day.

MOSQUITOES

Life History of Mosquitoes.—Mosquitoes pass through four stages in their development from egg to adult: (1) The egg stage—the eggs are laid by the female upon the surface of the water. (2) The larval stage—within 1 to 3 days after the egg is laid it hatches into the larval form, known as the " wiggle-tail." The larval form is of about one week's duration. While in the larval stage the organism breathes by a breathing tube or breathing pore near the posterior end. It receives its air by coming to the surface of the water. (3) The pupal stage—from the larval stage it passes into what is known as the pupal stage which lasts for 2 or 3 days. While in the pupal condition the organism is quite inactive and does not feed. It has two breathing " trumpets " on the back of its thorax. The pupa spends most of its time at rest at the surface of the water. (4) The adult stage—within 2 or 3 days the pupa becomes the young winged adult. The young adult crawls from the water upon an object which may be protruding from the water's surface, dries its wings, exercises them, and flies away. The first three stages in the life history are thus aquatic and the fourth stage is aerial. It requires about 10 to 15 days for the egg to become an adult mosquito. The females of most species of mosquito use blood as their food, while the males of all species suck the nectar of flowers for food. The female must have blood for two purposes; as food for her own body and to be used as food material in the development of young eggs which she already possesses. Thus both the instinct of self-preservation and the

instinct of reproduction urge her to seek blood. Perhaps the double urge of the two instincts accounts for her great persistency.

North American Genera.—There are three genera of mosquitoes found in the United States: (1) *Culex* mosquitoes are the most common and it is they which are the great nuisances when we consider only the stinging capacities of mosquitoes. *Culex* mosquitoes do not transmit diseases in the United States except in the vicinity of Charleston, South Carolina, where they distribute a tiny worm, parasitic in the blood stream of man. The worm is known as Filaria, and it was brought to that vicinity by slaves from Africa. *Culex* mosquitoes are semi-domestic, that is, they will lay their eggs in artificial containers about human habitation or will lay them in natural bodies of water far removed from the home of man. They will lay eggs in either clean or very unclean water.

(2) *Aedes* (*Stegomyia*) is the name of the genus of mosquitoes which transmits both yellow fever and dengue fever. *Aedes* is a warm-climate mosquito. In our country, its distribution is almost wholly limited to the Gulf Coast. In occasional years it migrates by means of boats and trains two or three hundred miles inland from the Coast and has in times past caused great epidemics of yellow fever as far north as Memphis, Tennessee, or even so far as Philadelphia and New York. As recently as 1922 it produced a widespread epidemic of dengue throughout Texas and Louisiana, reaching as far north as Dallas and causing several thousand cases there. *Aedes* is the most domesticated of the mosquitoes. It lays its eggs in artificial containers about human habitations. After the hatching of the eggs the adults hover closely about man's habitation during the remainder of their lives. Being the most domesticated mosquito, it is the most readily destroyed. Unlike the members of the other two genera, it flies and seeks its food by day rather than by night.

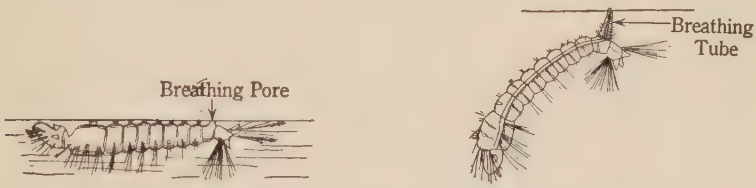
(3) The *Anopheles* genus is the one which disseminates malaria. This is the wildest and most undomesticated of the three genera. It prefers to lay its eggs in natural bodies of water. It lays its eggs in clear waters, frequently in running brooks that are sluggish in movement. There are three species of this genus which distribute malaria parasites. The *Anopheles* is the most difficult to reach and destroy. But they rarely migrate more than two miles from their native breeding places. When made to fly in winds they fly against the wind and soon alight. Hence they are not carried long distances by winds as is popularly supposed.

How to Distinguish the Three Genera.—*Culex* and *Aedes* belong to the same family of mosquitoes; consequently there are many resem-

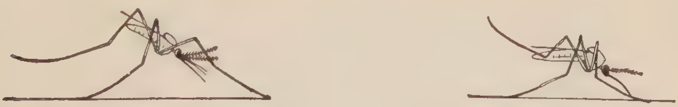
blances between them in structure and in habits. We shall compare *Anopheles* on the one hand with *Culex* and *Aedes* on the other (Fig. 26), discussing first the eggs, then the larvae, the pupae, and the adults.

ANOPHELES	CULEX AND AEDES

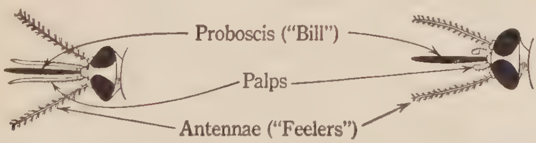
Eggs laid singly; have "floaters" filled with air. One is magnified.	Eggs laid in rafts; no "floaters." One is much magnified.



Larvae have no breathing tube—merely a breathing pore, which necessitates their lying parallel with water's surface.	Larvae have breathing tube and rest at an angle from the surface of the water.



The adult rests with the abdomen at an angle with the resting surface.	Adult rests with abdomen parallel with resting surface; humpbacked.



Palps of both male and female long, equaling the proboscis in length.	Palps of female always much shorter than proboscis; those of male usually as long as proboscis.

Fig. 26.—Distinguishing characters of mosquitoes and their eggs and larvae. (Modified from Chandler's "Animal Parasites and Human Disease," with permission of John Wiley & Sons, Inc.)

(1) The eggs of *Anopheles* are laid singly and separate. Each egg has a " floater " on each side in the middle portion of its length. The eggs of *Culex* are laid and glued together in rafts of 100 to 200 eggs. Upon

the surface of water the rafts look like particles of soot. The eggs of *Aedes* may be laid in small rafts loosely glued together, but the eggs may break apart and frequently are found separated from each other. *Aedes* eggs, under the microscope, look very much the shape of bananas, slightly curved and the sides rather angular. There are no floaters on the eggs of *Culex* and *Aedes*.

(2) The larva of *Anopheles* may be distinguished by the fact that it has no breathing tube near the posterior end of the organism. Because of the fact that it has only a breathing *pore* the larva when at rest at the surface of the water must lie parallel with the surface in order to receive air through the pore. The larvae of both *Culex* and *Aedes* have breathing tubes, rather long comparatively. The tube of *Culex* is quite slender, while that of *Aedes* is rather barrel-shaped. When resting at the surface of the water both of these larvae hang head downward at an angle of about 45°.

(3) The pupae of the three genera are very difficult to distinguish. The best method of identifying them is to rear them to adult mosquitoes, which requires only a day or two. They may be reared by putting them into a glass jar of water and covering the jar with cheesecloth. The types of water and conditions of habitat in which the eggs and young of the genera may be found have been described previously.

(4) The male adults of the three genera are non-parasitic, live in the vicinity of flowers, and are very short-lived. For these reasons the males are rarely seen. Soon after reaching the adult condition they fertilize the females and soon die. Therefore, it is more important to be able to distinguish the females.

The *palpi* of both male and female *Anopheles* are of about the same length as the proboscis. The palpi of the female *Aedes* and *Culex* are very short, perhaps one-fourth as long as the proboscis. But the palpi of the male of these two genera are usually as long as the proboscis.

The *resting position* of the adult *Anopheles* is not parallel with tne surface of the body upon which it rests; the body of the mosquito lies in a straight line and the abdomen is tilted from the resting surface at an angle of 45° to 60°. The *Culex* and *Aedes* adults usually are "humpbacked" and the abdomen is parallel with the resting surface.

Anti-mosquito Measures.—In describing anti-mosquito measures we shall not indicate which measures apply to any particular genus, since we have already indicated the types of habitat in which the eggs, young, and adults of each genus may be found. We shall describe the measures for eradication of all three genera, since all are undesirable neighbors, whether they convey disease or not. (1) Artificial containers of water

should be emptied or guarded from mosquitoes in some manner. We have reference to such containers as barrels, watering troughs, tin cans, clogged or sagging roof gutters, basins of water for bulbs or flowers, toilet tanks which are not in use, and pitchers of water kept in the old-established and much-respected institution, the guest-room. Frequently mosquitoes are found developing in the water from an ice-box which may be drained upon the ground beneath the floor. If water must be maintained in artificial containers, those containers may be screened with wire or cloth, or they may be emptied or drained once a week. (2) Filling in or draining may be applied to depressions in the ground where water may collect for the use of mosquitoes. Filling in of such places is preferable, if practicable. (3) Or, if neither filling in nor draining is practicable then crude oil may be sprayed upon the water, in sufficient quantity to form a scum over the entire surface. The oil should be re-applied every week or ten days. (4) " Top-minnows " frequently are used in the Southern States for the destruction of mosquitoes in streams or bodies of water which it is impracticable to fill, or drain or oil. Such top-minnows can be supplied by most state boards of health in the South. The top-minnows are voracious feeders. They feed upon the larvae of mosquitoes, one minnow may consume two or three hundred larvae in a single day. (5) Secondary measures of defense against mosquitoes are the screening of houses and of beds. The wire screen used for houses should have 16 to 20 strands of wire per inch. The door screens and window screens should fit very snugly into the facings.

Ridding the House of Mosquitoes.—The keyholes, nooks, and cracks of rooms should first be stopped with paper. Burning **sulphur** is a good insecticide, but it has the disadvantage of being corrosive, especially on humid days. That is, it tarnishes metals, it destroys fabrics, and bleaches colors in a humid atmosphere. Such articles should first be removed from the room. **Hydrocyanic acid gas** is extremely poisonous and dangerous to handle by inexperienced or uninstructed persons. If it is to be used, instructions may be had from the health officer. This is the most efficient of all insecticides. It not only kills insects, but also rats and mice. It is less destructive of articles of furniture, metals, and fabrics than sulphur. Neither burning sulphur nor hydrocyanic gas is a good germicide.

With a small handful of cotton, mosquitoes may be daubed and entangled when found on window screens of open windows in the evening at dusk and morning at dawn.

Quinine as a Malaria Preventive.—In some communities or in some conditions of life it may not be practicable to eradicate mosquitoes or

to protect oneself against those insects. Under such conditions it is advisable to take about two doses of quinine of proper size per week. If this practice is regular it prevents the multiplication of the malaria parasite in the blood.

OPTIONAL STUDIES

Yellow Fever

The causal agent was reported by Noguchi to be a small spirochaete which he named *Leptospira icteroides*. But some authorities appear to doubt that this is the causal agent. The source of the infection is the blood of infected persons. Yellow fever is transmitted by *Aedes* mosquitoes. The following are measures which are used in the control of yellow fever: (1) Isolation of patients from mosquitoes in carefully screened rooms. (2) Eradication of *Aedes* mosquitoes by destroying their breeding places, which are in artificial containers of water and in the immediate vicinity of human habitation.

The Conquest of Yellow Fever.—*In Havana.* It will be recalled that as a result of the Spanish-American War, the Americans occupied Cuba, including the city of Havana, in 1898 and remained in control of the island until 1904. There had been an average of more than 500 deaths in the city from yellow fever during the 10 years immediately preceding that war and Havana had been a stronghold of yellow fever for 140 years, with never a day when there was not a case of the disease in the city. In the first year of American occupancy the number of deaths from yellow fever was reduced to 136. The next year, 1899, there were 103 deaths; in 1900, 310. In 1901 a commission of American Army Medical men working in Havana discovered the fact that the *Aedes* mosquito was the transmitter of yellow fever. During that year there were only 18 yellow fever deaths in Havana and in the 3 years immediately following not a single death from the disease occurred. For the whole period since that time fewer than 50 deaths from yellow fever have occurred in Havana. As long a period as 18 years has passed without a death from that disease in the city.

The story of the discovery of the fact that the mosquito is the transmitter of yellow fever is one of the most inspiring in modern science. The Army Medical Commission sent to Havana for the purpose of working on the prevention of yellow fever was headed by Dr. Walter Reed. Other members of the Commission were Doctors Lazear, Carroll, and Agramonte, the latter being a Cuban and immune to the fever by reason of having previously recovered from it. The members of the Commission in the beginning suspected the mosquito as being the transmitter. They constructed small houses on the outskirts of Havana (Fig. 27), carefully screened the houses and were careful to see that no mosquitoes were loose in the rooms. Patients of yellow fever were taken to these little houses and members of the Commission slept in the beds of the patients, before and after death of the latter. They wore the clothing of the patients. None of the Commission received the disease by these close associations. Captured mosquitoes were then allowed to draw the blood of yellow fever patients. Such mosquitoes then were allowed to feed upon the members of the Commission. Two members of the Commission, Carroll and Lazear, contracted the fever. Lazear died from it and Carroll died from the remote effects a few years afterward.

This was an indication that yellow fever was transmitted by the mosquito, but it was not regarded as definitely proven. Eighteen soldiers volunteered to be bitten by mosquitoes which had fed upon patients. Most of the soldiers contracted fever and died. A bill is now before Congress which, if passed, will carry a pension of $250 per month for the survivors of this heroic group of men, a rather belated recognition of their remarkable contribution to humanity's welfare. *Later: the bill failed to pass!*

When the Medical Commission had established the fact that the *Aedes* mosquito was the transmitter of yellow fever, General Gorgas, medical officer in the Army, was placed in charge of sanitation in Havana. All breeding places of mosquitoes were destroyed, with results already described.

FIG. 27.—Camp Lazear. In this building was conducted that part of the yellow-fever experiments which proved that the disease is *not* transmitted by infected clothing, etc. The cabin consisted of a room, 14 by 20 feet, with two small windows facing south, closed with wire screens. Heavy wooden shutters excluded the sunlight. Entrance was through a small vestibule on the same side as the windows, protected by a wooden door and a screen door and separated from the main room by a screen door, to make perfectly certain that no mosquitoes could get in. This house was kept closed during the daytime and had a temperature of from 92° to 95° F. It was occupied for twenty nights by three American volunteers, and the test was repeated twice. (From Gruenberg's "Biology and Human Life," Ginn & Co.)

In Panama.—In 1904 the Americans acquired the Panama Canal from a French company which had been attempting for a number of years to construct "the ditch." But malaria and yellow fever had taken 18 out of every 100 men employed by the French company. "Each cubic yard of earth removed had cost a life." After the Americans had taken over the Canal, General Gorgas was placed in command of the sanitary forces and directed to make preparation for the preservation of the health of many thousands of workers to be employed on the Canal. Using the same methods of sanitary control which he had used in Havana, General Gorgas and his able lieutenant, Mr. LePrince, a sanitary engineer, soon converted the Panama Canal Zone from one of the most uninhabitable regions of earth into one of the most healthful places of the world. The death rate in the Canal Zone came to be only two-thirds as high as that in the United States. The author has heard one person say that he had walked from one end of the Panama Canal Zone to the other in recent years, without having observed a housefly or a mosquito.

At Guayaquil.—In 1918 the Rockefeller Institute for Medical Research sent Dr. Noguchi, an eminent bacteriologist, to Guayaquil, on the western coast of South America, to make an investigation as to the causal agent of yellow fever. Dr. Noguchi, after two or three years of work, reported a spirochaete as the probable cause of the fever. He called this spirochaete *Leptospira icteroides*. He also an-

nounced a serum which might be used with considerable effectiveness in both prevention and cure of yellow fever. Other investigators in Mexico and Central America worked upon the yellow fever problem. Among those working in Mexico was a young physician, Dr. Howard Cross, reared in Oklahoma. Dr. Cross sacrificed his life to the fever. His remains were buried at Lamont, 103 miles north from Oklahoma City.

During the past several years the Rockefeller International Health Board, in cooperation with the various governments in Central and South America, has suc-

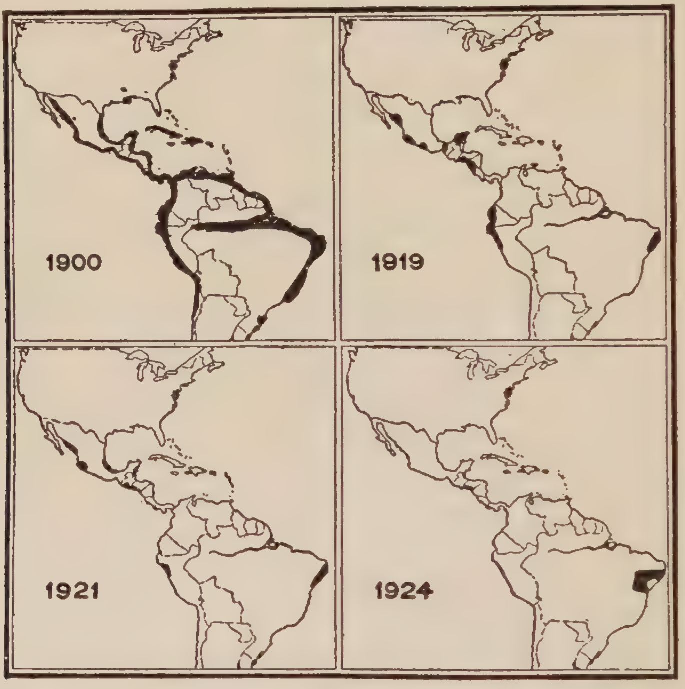


Fig. 28.—Yellow fever in retreat from the western hemisphere. In 1927 there were only 3 cases in the Americas, those 3 being in Brazil. (From Annual Report of International Health Board, 1924, and personal letter from same in 1928.)

ceeded in almost totally eradicating yellow fever from the Western Hemisphere. In the year 1927 there were only 3 cases of yellow fever in the New World (Fig. 28). They were located near Bahia, Brazil.

During the past two or three years the International Health Board has transferred its activities against yellow fever to the Western Coast of Africa, the only remaining endemic area for the disease. The lives of Professor Stokes, Dr. Young and the renowned Dr. Noguchi have recently been sacrificed to the yellow fever of Africa.

Eradication of Yellow Fever and Malaria Compared.—Malaria is more difficult of eradication than was yellow fever. There are the following named biological factors which make extermination of malaria more difficult: (1) Persons may be carriers of

the malaria germ for several years, whereas the yellow fever germ does not persist in the body of the recovered patient. (2) Malaria is widespread; it is not endemic in a few localities only, as was the case of yellow fever. (3) The mosquito transmitter of malaria parasites is *wild*, breeds in natural bodies of water far from the habitations of man, and flies as far as two miles from places where hatched; the transmitter of yellow fever is domesticated in its breeding habits and hovers closely about man's habitations during its life. These differences contributed to the ease of eradication of yellow fever and probably will prevent the total eradication of malaria for a number of years to come.

Dengue Fever

The causal agent of dengue fever is unknown. The source of the causal agent is the blood of infected persons. Recovered patients do not remain carriers. Dengue is transmitted from person to person by the *Aedes* mosquito. The incubation period is from 3 to 10 days. The period of communicability is from the day before the onset to the fifth day of the disease.

Measures for Control include the most careful screening of patients. Their rooms must be screened separately from the rest of the house. At the termination of the case the room should be fumigated by burning of sulphur or with hydrocyanic acid gas to destroy any mosquitoes remaining. As a second precaution the rest of the house should be fumigated in the same manner. A general measure of basic importance and a prevention of danger is the eradication of *Aedes* mosquitoes, remembering that they breed in artificial containers of water about habitations of man.

Fig. 29.—Dr. Hideyo Noguchi, martyr to yellow fever. Although Japanese in blood and by birth, Dr. Noguchi had done most of his life's work in the United States. His researches on syphilis and yellow fever had made him conspicuous as one of the world's leading bacteriologists. Notwithstanding the great honors which had been bestowed upon him from many countries, he continued extremely modest and retiring. While investigating yellow fever on the West Coast of Africa he contracted the disease and died in May, 1928. (From photograph furnished by Rockefeller Institute for Medical Research.)

The Texas Epidemic of 1922.—This epidemic started at Galveston in June, 1922. The epidemic began from a patient brought into Galveston on a boat from Central America. The disease spread from Galveston to Houston, then along the railways throughout the eastern half of Texas and into Louisiana. It was estimated by the Texas State Board of Health that there were 500,000 to 600,000 cases in that state. There were about 30,000 cases in Galveston, 30,000 in Houston, and 20,000 in Dallas. It was further estimated that there were 3,750,000 labor days lost in Texas because of the epidemic. At an average of $3.00 per day the labor loss amounted to $11,250,000, an inexcusable loss from an entirely preventable disease. During the epidemic Chandler and Rice, experimenting upon volunteers, found the incubation period to

be from 4 to 6½ days. They furthermore confirmed *Aedes* as the transmitting mosquito of dengue. They were unable to obtain transmission by *Culex*, although *Culex* had been claimed by some to be the vector of dengue. They found also that the mosquito was able to transmit the disease within 24 to 96 hours after feeding upon patient, which short period indicates that the mosquito is a mechanical transmitter rather than a biological transmitter of the disease.

The mortality rate of dengue is exceedingly low, only a fraction of 1 per cent of cases. Dengue is confined to tropical and sub-tropical regions, because the transmitting mosquito is so limited in its geographic distribution.

Bubonic Plague and Fleas

The causal agent of bubonic plague is *Bacillus pestis*. The source of the causal agent is the blood of infected persons and that of certain animals, particularly the rat and the ground squirrel. Plague is a disease primarily of rats; it is not a disease of man primarily at all. Man receives it from infected rats by the bite of fleas which have recently bitten infected rats. The flea transmits the bacillus mechanically from infected rats to man. The incubation period is from 3 to 7 days. Control of the disease depends upon suppression of rats or fleas. Since rats are more easily exterminated than fleas most effort for control of disease is centered upon destruction of rats. The rats are exterminated by poison, trapping, elimination of food supplies of rats, rat-proofing of houses, etc.

Geographic Distribution.—Plague is confined mostly to Eastern Europe, Asia, and Africa. Occasionally there is an outbreak in our own country, most of such outbreaks occurring on the Pacific Coast or in the towns on our Gulf Coast. The disease has become endemic to those two sections of the country, that is, it is harbored by the rats and ground squirrels of those sections.

The Pneumonic Form.—Occasionally the *Bacillus pestis* causes an epidemic by entering the lungs and producing a disease much similar to that of lobar pneumonia. In this form it is termed *pneumonic* plague. The pneumonic form is very highly fatal, perhaps 90 per cent fatal. In the year 1924 an outbreak of the pneumonic form of the plague occurred at Los Angeles.

Typhus Fever and Lice

The causal agent of typhus fever is *Rickettsia prowazeki*. This organism receives its genus name, *Rickettsia*, from a young professor in the University of Chicago, Dr. Howard Taylor Ricketts (Fig. 30), who was the discoverer of this genus of parasitic organisms. Dr. Ricketts lost his life from typhus fever while in Mexico City seeking to find a method for preventing the disease. Before losing his life, Dr. Ricketts discovered the germ and suspected the louse as being the transmitter. The species name, *prowazeki*, is in honor of a Polish bacteriologist, Prowazek, who also sacrificed his life to typhus fever while making a scientific investigation of it. This disease is noted for its treachery, several noted bacteriologists having been sacrificed to it. More recently Bacot, an Englishman, died of typhus while studying it in Egypt. Typhus fever is disseminated from person to person by the head louse and the body louse, especially the latter, as was finally established during the World War. Therefore the prevention of typhus depends upon the extermination of lice and the establishment of cleanly personal habits. This disease frequently crosses into the United States from Mexico, where it is fairly prevalent.

Tularemia

Causal Agent.—A bacillus, called *Bacterium tularense.*

Source of Causal Agent.—The blood and tissues of the rabbit, ground squirrel, pocket gophers, wild mice, woodchucks and other rodents. The disease is primarily one of the rodents and secondarily of man. The rodents compose the reservoir from which the disease is derived by man.

Transmission.—From the animals mentioned it may be transmitted to man by the deer-fly or horse-fly or by a species of tick or perhaps by other insects. But in most cases man has contracted the disease by dressing the infected animals, especially rabbits, or by other direct contact with the carcasses of such animals. Many of the cases have been contracted through wound of the skin on hands while in contact with the carcasses. But it appears also that a number of cases were contracted through the unbroken skin. The causal agent lives in the dressed carcass for as long as 3 weeks. Of 914 dressed rabbits in the markets of Washington, D. C., 7 contained the living, virulent *Bacterium tularense.*

FIG. 30.—Dr. Howard Taylor Ricketts, martyr to typhus fever. Dr. Ricketts, young professor in the University of Chicago, first became known as an eminent bacteriologist as a result of his researches on Rocky Mountain Spotted Fever. In Mexico City he discovered the typhus fever germ (*Rickettsia*, named in his honor) but contracted the fever and died of it. The two buildings housing the bacteriology department on the campus of the University of Chicago are named for him.

Incubation Period.—From 2 to 5 days.

Prevention consists in avoidance of direct physical contact with infected animals, especially rabbits. Market men and persons dressing rabbits would reduce the chances of contraction by wearing rubber gloves. Rabbits which appear unusually tame are to be avoided; they may be sick.

History.—Tularemia was first described in 1911 in California, county of Tulare, which accounts for the name of the disease. It is also known as "rabbit fever" and "deer-fly fever." The disease has now been found in nearly every state in the Union. It appears that the disease is not so new as the newspapers would have their readers believe. Since the dissemination of knowledge of the disease among medical men many physicians recognize it as a disease which they had seen occasionally for years before.

Symptoms and Fatality.—Tularemia is highly fatal to the rodents named above, killing practically all it attacks. But it is rarely fatal to man. In man the fever lasts two to three weeks or longer, followed by a very slow recovery. In its symptoms it much resembles typhoid.

CHAPTER V

DISEASES THAT ENTER THE BODY THROUGH WOUNDS AND HOW TO AVOID THEM

Of the diseases the causal agents of which gain entrance to the body by way of wounds through the skin, the following will be considered: rabies (hydrophobia); tetanus (lockjaw); "blood poisoning"; and the pus-forming infections.

RABIES (HYDROPHOBIA)

Causal Agent.—Unknown. Some regard the "Negri bodies," which are found with the microscope in the gray matter of the spinal cord and brain of animals which have "gone mad," as the causal agents of the disease. Others believe the "Negri bodies" to be results of the disease rather than the causal agent.

Source of the Causal Agent.—The source is the saliva of infected animals, chiefly dogs. The germs, whatever they are, are in the saliva.

Exit of the Causal Agent from the body of the infected animal, as already indicated, is by way of the saliva.

Entrance of the Causal Agent is usually through the torn or broken skin of the person or animal, the wound produced by a rabid animal's bite. Also, the virus may gain entrance through an imperceptible break or abrasion of the skin if contaminated saliva comes in contact with such abrasion, as, for instance, from the lick of an infected dog.

Agents of Transmission.—The bite of an animal, usually of the dog. Other animals which sometimes transmit the disease are cats, skunks, cows, etc.

Incubation Period.—Usually 2 to 6 weeks, but may be 6 months or longer.

Period of Communicability.—From 15 days preceding symptoms in the dog, and throughout the course of the disease.

Measures for Control.—(1) When the disease is suspected in an animal confirmation of symptoms should be sought by confining the animal and observing for two weeks. If the animal has been killed already, examination of the brain of the animal for "Negri bodies."

(2) Warning of members of the patient's family and of his attendants of the possibility of their being infected with his saliva. (3) Preventive vaccination of all persons who were exposed by the biting of an animal found to be rabid. The vaccination should be done as soon as possible after infection. The sooner the vaccine is administered the less the chance of the development of symptoms. (4) Concurrent disinfection of saliva of the patient and articles soiled therewith. Such disinfection may be by boiling or burning. (5) Terminal disinfection of patient's room by washing with formaldehyde, or carbolic acid, or bichloride of mercury. The room then should be thoroughly scrubbed with hot water and soap. (6) Muzzling of dogs. (7) Annual vaccination of dogs to immunize them. (8) Detention and observation of dogs suspected of having rabies.

How to Ship Head of Suspected Animal.—If a person has been bitten by an animal suspected of being rabid, the better method is to confine the animal and keep under close observation for two weeks. (The bitten person takes the vaccine in the meantime.) But if by unfortunate chance the animal has been killed then its head should be cut off, packed in ice and sent to a laboratory for microscopic examination for "Negri bodies." If the head is decomposed when it reaches the laboratory an examination is useless. Therefore, it is very necessary that the head be shipped in ice. A wooden container in which ice cream is packed for shipment is convenient for icing and shipping a head.

How the Rabies Vaccine is Made.—A series of several rabbits are inocculated with the rabies virus. The rabbits usually die of rabies within 10 days. However, ordinarily they are not allowed to die of the disease but through humane consideration are chloroformed. The spinal cords of these rabbits are removed and dried. The cord of rabbit No. 1 is dried for only one day; that of No. 2 for 2 days; that of No. 3 for 3 days; etc. None of the cords is dried for more than 6 or 7 days. It has been found that the drying of the cords kills the rabies virus within them in 5 days. After the various spinal cords have been dried for their respective periods of time, each cord is then ground up and put in salt water to form an emulsion or suspension. The various suspensions are numbered as were the rabbits mentioned above. These suspensions are the rabies vaccine.

How the Vaccine is Administered.—The vaccine is injected beneath the skin of the person who has been bitten by a "mad" animal, as soon as possible after the bite. It is administered daily for about 14 or 15 days. The first day's treatment consists of an injection of vaccine made from spinal cords which were dried 6 or 7 days, usually 6 days.

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The second day's treatment consists of vaccine from cords that were dried 5 days. On the third day of the treatment vaccine is used which was made from cords dried for 4 days. During the rest of the treatment, or immunization process, vaccine is used made from cords dried 3 or 2 days. Thus, in the immunization process first vaccine is used in which the virus is entirely killed, then the vaccine used is that in which the virus has only been attenuated or injured by the drying process. It will be seen that the strongest or least attenuated virus is used in the last part of the immunization. Beginning with the weaker vaccine and proceeding gradually to the stronger enables the patient to build up resistance against the stronger so that it gives him but little inconvenience when it is received. The rabies vaccine is highly efficient in preventing the development of the disease, if used soon after the bite is received. But it is of little or no use for treatment after symptoms of the disease have developed. The immunization process described above is known as the Pasteur treatment. There are three or four modifications of the original Pasteur method.

The First Use of the Rabies Vaccine.—The first use of the rabies vaccine came in the 1880's. Pasteur had developed the vaccine and with it had successfully immunized animals against rabies. His success in immunizing animals became widely known. In the eastern part of France, not far from the home of Joan of Arc, a boy was bitten many times by a rabid dog when the lad came to the assistance of some small children that were attacked by the dog. There was no doubt of the dog's having rabies. The boy was brought to Pasteur, who, in fact, was not a physician, but a chemist and the founder of the science of bacteriology. Pasteur conferred with physicians and with the parents of the boy. It was decided that the boy was almost certain of death unless he could be saved by the vaccine which had proved so successful with animals. The vaccine was administered, in daily doses or " shots " in much the same manner as the method described above. As the less attenuated or stronger vaccine doses were approached the great Pasteur grew nervous and wakeful. But the vaccine was continued. When the last dose had been received, the boy showed but little reaction. The lad never developed rabies. He was immune. This was the first great triumph in the prevention of human disease by artificially made vaccine. (See Frontispiece.)

Prevalence of Rabies.—Rabies is known in most parts of the world. Australia, however, has never had rabies; it is prevented from entering that country by strict laws regulating the importation of dogs. England had practically eradicated the disease, by rigid enforcement of laws

requiring muzzling of dogs and of laws regarding importation of animals; but during the World War dogs brought to England in airplanes again established rabies in the island. In the United States we have rabies outbreaks in several hundred localities each year, but due to the common use of the Pasteur treatment, fewer than 100 deaths occur annually. Rabies treatment and the loss of labor are expensive. Besides, " mad " dogs cause much undesirable excitement and anxiety on the part of the populace. Compulsory muzzling and vaccination of dogs is well worth while in any community. Muzzling is more effective than vaccination.

TETANUS (LOCKJAW)

Causal Agent.—*Bacillus tetani.* This bacillus is an anaerobe and a spore former.

Source of Causal Agent is the dung of herbiverous animals, especially of horses and cattle. The tetanus bacillus lives normally and habitually in the intestines of these animals, and occasionally is found in the human intestine. Therefore, animal manure, soil—especially that which is heavily fertilized with manure—and street dust may teem with great numbers of spores of this bacillus.

Exit of Causal Agent from the body of the lower animals has been indicated already as being in the dung. The causal agent does not ordinarily escape from the blood of an infected person, for the bacillus remains confined locally in the vicinity of the wound.

Entrance of Causal Agent into the body of potential patient is gained through wounds made in or through the skin. If the bacillus or its spores are received through the mouth into the intestine they produce no effect.

Agents of Transmission are splinters, nails, pins, and such other objects as may produce a wound and carry contaminated soil or spores of the bacillus into the flesh. Some persons have a notion that the tetanus germ prefers rusty nails as a habitat. The causal agent has no special affinity for rusty nails—although, of course, rusty nails may have the bacilli upon their surfaces and may introduce them into flesh just as may splinters or other sharp objects.

Period of Incubation is from 4 days to 3 weeks or even longer.

Period of Communicability.—The patient ordinarily is not infective, only when discharges from the wound may be introduced into the flesh of another person.

Measures for Prevention.—(1) Immunization of persons with suspicious wounds by means of immediate injection of tetanus antitoxin.

Thorough cleansing of such wound by a physician. (2) Propaganda for "safe and sane" Fourth of July celebrations.

The Tetanus Bacillus.—This organism, it has been indicated, is an anaerobe, that is, it grows in an absence of free oxygen of the air. It is more likely to grow in closed wounds than in open ones. It is more likely to be found in wounds which are badly torn and which contain quantities of dirt. Therefore, wounds should be opened and thoroughly cleansed by a physician.

Spore Production.—The tetanus bacillus produces spores which are highly resistant to weather and to heat. In most cases, however, the tetanus spores are killed when boiled in water for an hour. They may resist weathering and live in the soil for years. It is usually the introduction of spores into flesh which causes the lockjaw. Spores are likely to be found in great numbers about barnyards, in highways and streets, and manured gardens or fields. During the recent World War wounds of soldiers contaminated by the highly fertilized soil of Belgium harbored tetanus bacilli and an unusually high incidence of tetanus resulted, until the soldiers were given instructions on how to prevent the development of tetanus.

The Tetanus Toxin.—The tetanus toxin is an exotoxin, and is, of course, soluble. The tetanus bacilli do not ordinarily leave the site of the wound. But the soluble toxin which they produce may be absorbed through the tissues and into the blood stream. Or the toxin may travel from the wound along nerve trunks to the spinal cord. This toxin has special affinity for the nerve tissue in the brain and spinal cord and causes failure of the nervous system to control the muscles properly, especially those of the neck and lower jaw so that the muscles of those parts become very tautly contracted. This tetanic condition of the muscles subsequently extends to other muscles of the body. Death may result from exhaustion of the patient under the powerful muscular contractions.

The Tetanus Antitoxin.—The tetanus antitoxin is produced in much the same manner as is the diphtheria antitoxin, by injection of small but increasingly large doses of the tetanus toxin into a horse. The horse serum, obtained by bleeding the immunized animal, contains the antitoxin.

The tetanus antitoxin is highly effective in the prevention of tetanus in persons who have received infection with the tetanus bacilli. It is also of some use in the cure of tetanus after the disease symptoms have appeared, but it is not so efficient as a cure as it is as a preventive. Supposing that a person has received tetanus bacilli or spores into a

wound, explain how the administration of tetanus antitoxin would prevent the development of symptoms.

"BLOOD POISONING"

So-called Blood Poisoning is the result of entrance of microorganisms through wounds of the skin. The microorganisms are Streptococci in most cases. Immediately on receiving a wound, mercurochrome or tincture of iodine should be applied liberally. Care should be taken to see that the antiseptic reaches the bottom and all parts of the wound. It is better to apply no dressing than to apply any not thoroughly sterile. Never should water be used on a wound, however clean the water may be. Water will carry organisms into the wound from the skin and other sources and deeper into it. The longer the antiseptic is delayed the less useful. It should be applied immediately, within an hour. But little pus is formed in "blood poisoning" produced by Streptococci.

THE PUS-FORMING INFECTIONS

The microorganisms which cause much pus in wounds are usually Staphylococci. The pus is composed largely of fluid, bacteria and white blood corpuscles, which latter have migrated to the wound for the purpose of ingesting and digesting the invading microorganisms, but which have themselves been destroyed by the hardier bacteria. To prevent pus-forming infections, apply mercurochrome or iodine to wounds immediately.

SUMMARY STATEMENT

A great amount of inconvenience, suffering, worry, loss of labor and even loss of life occur each year because of neglect of wounds. However insignificant a wound may appear, it should be sterilized immediately with mercurochrome or tincture of iodine. If the wound is deep or closed, there is distinct danger of tetanus and a physician should attend at the earliest possible time.

CHAPTER VI

THE SEXUAL DISEASES

The sexual diseases are so called because they are usually contracted in sexual intercourse and usually affect the sexual organs first, that is, they affect the sexual organs before extending to other parts of the body. They are not confined to the reproductive organs alone, nor indeed do they always enter the body by way of the organs of sex.

There are two of the serious venereal diseases: gonorrhea and syphilis.

"As a danger to the public health, as a peril to the family, and as a menace to the vitality, health, and physical progress of the race, the venereal diseases are justly regarded as the greatest of modern plagues, and their prophylaxis the most pressing problem of preventive medicine that confronts us at the present day."

It is estimated that one-fifth or more of the adult population of one of the large cities, for instance, has, or has had, one or both of the two chief venereal diseases. Syphilis affects 8 per cent to 10 per cent of the total population of the country as a whole. Professor Rosenau calls gonorrhea the great preventer of life and syphilis the great destroyer of life. Gonorrhea is the great preventer of life because it produces about 50 per cent of the sterility prevalent; syphilis is termed the great destroyer because it accounts for nearly half of abortions and miscarriages and for 35 per cent of all insanity, and is one of the chief causes of mental and physical deficiency in children.

The chapter on Reproduction and Sex Hygiene might very profitably be read before this chapter.

GONORRHEA (CLAP)

Causal Agent is the *Gonococcus*, which is a diplococcus.

Source of the Causal Agent.—Discharges from the inflamed lining membranes of the sex organs or from the inflamed membranes of the eyelids of an infected eye.

Exit of Causal Agent from an infected body is usually by way of the passages of the generative organs.

Entrance of Causal Agent is usually gained by way of the passages of the sex organs.

Mode of Transmission is usually by sexual intercourse, mostly illicit intercourse. May also be transmitted by contact with articles of clothing freshly soiled with discharges from an infected person.

Incubation Period is 1 to 8 days, usually 3 to 5 days.

Period of Communicability.—As long as the gonococcus persists in any discharges. The gonococcus may cease to appear in the discharges for even a long period of time, then reappear. It is difficult for the physician to determine when a patient is permanently cured.

Measures for Prevention.—(1) Abstention from sexual contact when the genito-urinary tract is infected. (2) Concurrent disinfection of discharges and articles soiled with them by burning or boiling in water. (3) Avoidance of infecting the eyes with contaminated fingers. (4) Popular information of the fact that sexual intercourse is not necessary for health in either of the two sexes. It has been widely taught by ill-advised persons that sexual exercise is necessary for the health of the male. Even Benjamin Franklin taught this error. The medical profession stoutly denies the truth of such teaching. (5) Provision in hospitals and dispensaries for treatment of infected persons, especially the poor, and provision for keeping up with those cases until really cured. (6) Repression of prostitution. (7) Restriction of sale of alcoholic beverages, for alcohol excites sex impulses and breaks down will-power to resist. (8) Prohibition of the advertising of quack medicines for the treatment of gonorrhea. (9) Elimination of common towels and toilet articles from public places. (10) Exclusion of infected persons from preparing and serving of food in public places. (11) Use of preventive silver solution in the eyes of the new-born.

Incidence.—This is one of the oldest known diseases of the human race. It was described in Chinese literature several hundred years B.C. Next to measles it is probably the most prevalent of all the serious infectious diseases. It is one of the most communicable of all the infectious diseases. Under present knowledge, gonorrhea is difficult to cure and many times it is impossible even for the physician to know that a permanent cure has been effected. Old or latent cases are also frequently difficult to recognize. Many physicians assert that they prefer to undertake the cure of syphilis, even, to that of gonorrhea.

Nature of the Disease.—The Gonococcus first attacks the lining membranes of the urinary passages, causing profuse pus formation, usually. After the gonococcus has eroded away the lining membrane of the passages of the generative organs it may enter the blood stream

and be carried to distant parts of the body. The gonococcus may set up an inflammation in the heart, for instance, and produce death. Or it may cause gonorrheal rheumatism in the joints of the bones, which is one of the most damaging and disabling of gonorrheal complications.

In the male, abscesses of the prostate gland and inflammation of the testicle may result by passage of the gonococcus into those parts. Thickened scars may cause closure, or stricture, of the male urinary passage.

In the female, inflammation of the womb or uterus, of the Fallopian tubes, or of the ovary may be produced by the gonococcus making its way upward through the uterus and Fallopian tubes. The gonococcus may even cause inflammation of the inner lining of the abdominal cavity of the female. Medical men who make a specialty of women's diseases assert that much of their practice is made up of the consequences of gonorrhea. From 75 per cent to 80 per cent of all operations made on the female organs are due to gonorrheal infections.

The gonococcus may gain entrance to the eyes by way of fingers and produce severe inflammation or even blindness. Infants born of gonorrheal mothers may have the eyes infected with the gonococcus with resulting blindness. A large percentage of persons blind from birth owe their blindness to gonorrhea. Silver nitrate or argyrol solutions are used to sterilize the eyes of infants. Many states now require by law that the physician, nurse, or midwife attending at childbirth shall use one of these sterilizing agents in the eyes of all infants regardless of what may be thought of the past history of diseases in the mother.

From the point of view of racial welfare sterility is the most serious consequence of gonorrhea. Frequently the male is sterilized when the gonococcus attacks the testicle. The female may be sterilized by the closure of the Fallopian tubes as the result of gonorrheal scars within those tubes. It is said that one-half of the cases of sterility are due to gonorrheal infections.

SYPHILIS (POX)

Causal Agent.—A spirochaete, called *Treponema pallidum* (also called *Spirochaete pallida*).

Source of Causal Agent.—The discharges from the lining membranes of the genito-urinary passages, and of the mouth, nose, and throat; discharges from the lesions of the skin; the blood of infected persons; and articles freshly soiled with such discharges or blood. Blood of mother may infect child before birth.

Exit of Causal Agent from the infected body is indicated above.

Entrance of Causal Agent to the body is gained through the skin; or through the lining membranes of the generative organs, or of the mouth, nose, or throat. It is claimed that the treponema cannot enter through the skin except at such places as where the skin is broken. However, such an abrasion of the skin may be unnoticeable or imperceptible.

Agents of Transmission may be towels, drinking cups used in common, razors, dental instruments, etc. The spirochaetes were found in experiments to be living on drinking cups a half hour after they were placed thereon.

Incubation Period.—Usually about 3 weeks pass before the chancre, the first stage of syphilis, develops. But instances are on record in which the chancre did not develop for as long as 70 days. The chancre, or sore, develops at the point where the spirochaete gained entrance through the skin or membrane.

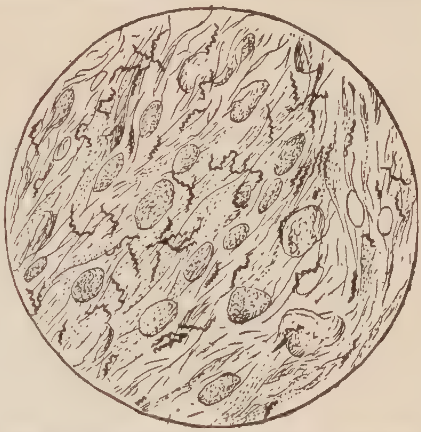

Fig. 31.—*Treponema* (*Spirochaete*) *pallidum*, the germ of syphilis, in liver tissue. The tiny black spirals are the germs. (Reprinted by permission from "Animal Parasites and Human Disease," by Chandler, published by John Wiley & Sons, Inc.)

Period of Communicability.—An infected person may communicate the disease as long as lesions are open upon the skin or as long as lesions exist upon the mucous membranes of the genito-urinary passages or of the nose, mouth, or throat.

Measures for Prevention.—(1) Exclusion from preparation or serving of food during the period of communicability, as determined by a physician. (2) Training of patients in matters of hygiene so as to prevent them from infecting other persons through common use of towels, drinking cups, etc. (3) Concurrent disinfection of discharges from patients and of articles soiled therewith by boiling or burning or otherwise. (4) Education of public as to the fact that continence in both sexes and at all ages is compatible with health. (5) Provision for treatment of the poor in particular at hospitals and dispensaries. (6) Repression of prostitution. (7) Restriction of sale of alcoholic beverages. (8) Restriction of advertising quack remedies for sex

diseases. (9) Abandonment of the use of towels in common, of common drinking cups, etc.

Incidence.—It is believed that about 8 per cent of the general population is syphilitic. The syphilis rate is higher among the classes lowest socially. Of the young men and young women of the better classes of society from 2 to 20 per cent are syphilitic, the percentage varying rather widely in different communities. Most prostitutes are syphilitic, 50 to 100 per cent of them. Criminals and the mentally deficient are syphilitic to the extent of 20 to 40 per cent. It is believed that the syphilitic rate among the colored race is more than twice as high as among the white race. About one-fourth of the negroes of Galveston, Texas, were found to have either gonorrhea, or syphilis, or both. Many deaths recorded in health offices as being due to paralysis, locomotor ataxia, apoplexy, and disease of the heart and arteries are in reality due to syphilis which produces those diseased conditions. Thus, syphilis is the direct or indirect cause of more deaths than any other disease. It should be stated, however, that not all cases of paralysis, apoplexy, and heart disease are due to syphilitic infection, for most are not. Of insanity, 10 to 35 per cent is due to syphilis.

History of Syphilis.—This disease was not known in the Old World before the time of Columbus. At the time of one of Columbus' visits to the Island of Haiti some of his men contracted syphilis from the Indians. The disease was thus carried to Spain. Some of the men who had accompanied Columbus to the New World and who had become infected with syphilis joined the army of Charles VIII of France when he invaded Italy in 1494 and set up the Kingdom of Naples. After arrival at Naples the army became greatly weakened by the ravages of this new and terrible disease, for syphilis in those times did its deadly work much more swiftly than at present. Charles' kingdom was short-lived, due perhaps indirectly to the ravages of syphilis among his soldiers. When he was overthrown at Naples his army, made up of mercenary soldiers of many nations, scattered and the soldiers returned to their home countries, thus distributing the disease throughout Europe. Some authorities, however, do not accept the American origin of syphilis as being correct.

It was not until 1902 that syphilis was successfully transmitted to animals, monkeys, where it could be conveniently studied. In 1905 the *Treponema* was discovered to be the cause of the disease. In 1906 Wassermann showed that cases of syphilis which could not be detected by the physician could be demonstrated by a blood test, now called

the Wassermann Test. The Wassermann blood test was a great advance toward the conquering of the scourge. In 1910 Paul Ehrlich discovered his famous drug, salvarsan or "606," which is a compound of arsenic and a poison deadly to all spirochaetes and highly useful for syphilis in most stages. In 1913 Dr. Noguchi discovered, by the finding of spirochaetes in the central nervous system, that syphilis was the cause of many of the cases of insanity, many of the cases of paralysis and of other diseases of the nervous system. Thus in a short period of 11 years several vitally important discoveries were made relative to syphilis and its cure.

Nature and Stages of the Disease.—There are four stages of the disease: (1) The *Primary* stage is the chancre stage. The chancre, frequently called *hard* chancre, appears at the point on the skin or lining membrane where the spirochaete made its entry into the tissues. It is a hard ulcer and is usually painless. It makes its appearance in about 3 to 5 weeks after the entrance of the spirochaete. The chancre is filled with great numbers of *Treponema* and is highly communicable.

(2) The *Secondary* stage appears at about 6 weeks after first evidence of the chancre, usually. In this stage appear eruptions upon the skin, upon the mucous membranes of the mouth, nose, and throat; and fever. The hair may fall out; headaches may occur; pains in the joints and bones may be experienced; and sore throat is common. This stage may last from a few months to several years. These manifestations in a large number of cases are so mild as to escape unnoticed. The eruptions of the skin and lining membranes are filled with spirochaetes and discharges from those eruptions are highly infectious. Except sexual congress, kissing is the most prolific method of disseminating syphilis. Kissing is especially hazardous in the second stage of the disease, when lesions are upon the mucous membrane of the mouth. A few years since at a social party held by young people in a certain large city a kissing game was among the diversions. A young man who had a syphilitic chancre on the lip kissed 13 girls. Eight of these young women later developed chancres about the face. The secondary stage of the disease is also the one most likely to give rise to new infections through the use of towels in common, handkerchiefs, soiled bed linen and other similar agents of transmission, especially if lesions are on the skin. Most cases of syphilis are contracted from patients in either the primary or secondary stage.

(3) The *Tertiary* stage usually begins as much as three years from the time of the appearance of the chancre and may last indefinitely. In

this stage the internal organs become involved with symptoms. Very few cases of syphilis are contracted from tertiary patients.

(4) The *fourth* stage occurs several or many years after the initial infection. This stage is characterized by inflammation and the degeneration of the heart, blood vessels, and central nervous system. Hardening of the arteries, which, however, is normal in old persons, is characteristic of the fourth stage of syphilis. The spinal cord may become so degenerated that the victim is unable to use the lower limbs normally, which condition is termed locomotor ataxia. In advanced degrees of the fourth stage insanity may occur. To pass through all stages of syphilis usually requires several to many years. During the first years of the disease's ravages in Europe the victims lived only a comparatively short period of time after infection. There is thus an indication that the human race is slowly becoming immune to syphilis. Yet the life of the average syphilitic is reduced one-third at the present time.

Treatment.—Salvarsan, or "606," is an arsenical compound. Its discovery by Ehrlich was the result of several years of effort. There are several modifications of Salvarsan, such as Neo-Salvarsan, Arsphenamin, Neo-arsphenamin, etc. The Salvarsan, or a modification of the preparation, is injected intramuscularly. This treatment is usually accompanied also by treatment with mercury and bismuth. It requires one and one-half to three years to effect a cure, when a cure is possible. Wassermann blood tests are made at repeated intervals and found to be negative before the physician pronounces the case cured. The medical profession regards it as inadvisable for one to marry until three years shall have passed after the last evidence of the disease by the Wassermann test or by the more recently devised Kahn blood test. Most cases in the primary and secondary stages are curable. Possibly most cases in the tertiary stage may be cured. But it should be said that damages already done to the body by the spirochaetes cannot be repaired, even though the *Treponema* may be killed by treatment. Organs damaged remain so for life.

Some states prohibit persons having either of the two chief venereal diseases from marrying.

CHAPTER VII

SOME NON-COMMUNICABLE DISEASES AND HOW THEY MAY BE AVOIDED

THE diseases here considered are not communicable diseases. That is, they are not communicated from one person to another, or from an animal to a person, like those groups of diseases already studied. Neither are they caused by germs. But they are preventable to greater or less degree, which accounts for their being considered in a textbook of this type.

CANCER

Nature of the Disease.—Cancer usually reveals over-rapid multiplication of cells in a limited area of the body. For some reason unknown the body cells in an area may start multiplying at abnormally high rate, thus producing the enlarged tumor. It is not believed by pathologists that cancer is a germ disease, notwithstanding the erroneous notions propagated by newspaper science. Most pathologists believe that the cancer is provoked by some unknown derangement in the chemical balance of the body or of a portion of the body.

Cancer as a Preventable and Curable Disease.—Cancer is preventable to a considerable degree, and this accounts for the inclusion of a discussion of cancer in this book. Probably 20 to 30 per cent of cancer could be prevented or cured under the present state of knowledge, if the cases were brought to the attention of competent physicians sufficiently early in the stage of development.

In cancer, blood vessels within the area may be so eroded that their walls are destroyed to such a degree that fragments of the cancerous tissue get into the blood stream and are carried to distant parts of the body where the cells of fragments may continue multiplying and in this way start new cancers in those parts. This distribution of cancerous tissue from the primary growth through the body and the resulting production of secondary cancers is termed *metastasis* by the medical men. Cancer may be cured by surgery or by radium or by X-ray, if

attacked before metastasis occurs. At the present stage of knowledge surgery is regarded by many medical men as the most dependable method of cure in most cases. It is of the utmost importance that suspected cancer be attended at once by a competent physician. It must receive attention before metastasis; after metastasis occurs it is then too late.

Prevalence and Incidence of Cancer.—One of the leading causes of death is cancer. Annually there are about 100,000 deaths in the United States from this disease. The disease attacks most the middle-aged and the old. Of cancer deaths 95 per cent are of persons above 35 years of age, it not often being found in the young. Of women above 40 years of age 1 in 8 die of cancer; while of men past 40, 1 in 14 die of this disease. Cancer appears to be on a fairly rapid increase in incidence. Some authorities claim that this apparent increase is due to improved diagnostic methods and to the increase in number of persons who reach old age. Other authorities deny and assert that the increasing cancer death rate is a real increase. It appears that the preponderance of opinion is with the last named group of authorities.

Organs Affected.—We shall name in more or less accurate order the organs of the body which are most likely to become cancerous, naming the organs most frequently attacked first.

(1) The liver is perhaps the most frequent site of cancer. But usually the liver is a secondary site, that is, the liver usually develops cancer as a result of metastasis occurring from a primary cancer in some other portion of the body. Little or nothing can be done to cure cancer in the liver.

(2) The stomach is the most frequent site of primary cancerous growth. Usually cancer of the stomach is discovered too late for surgery to be of use. Other methods of treatment are not often used for cancer of the stomach, because of inaccessibility. Indications of cancer in the stomach are persistent indigestion, persistent distaste for meat, and vomiting. Ordinary ulcers of the stomach may become cancerous. The deeper and most inaccessible parts of the body present the greatest difficulties in the treatment of these tumors.

(3) Another frequent site of cancer is the uterus. It is about the second or third most frequent site in women. The uterus is fairly accessible and cancerous growths of the uterus quite frequently are prevented or cured. Symptoms of cancer in the uterus are irregular menstruation; or after the " change of life " there may be an irregular watery, bloody discharge attending the development of the cancer. Any woman past thirty and experiencing these symptoms should see a physician immediately and insist on a most thorough examination.

(4) The breast also is one of the most frequent sites of cancer in the female. Any persistent lump in the breast should arouse the gravest suspicion. Removal of the breast frequently prevents the development of cancer, while without removal similar conditions in other women lead to the malignant tumor.

(5) Cancer of the esophagus or gullet is not infrequent.

(6) Cancer of the intestines is frequent. Little can be done as a cure.

(7) The rectum is another frequent site of cancer. Unfortunately "piles" are frequently confused with cancer and the consequent delay results fatally. If cancer of the rectum is brought to the attention of a competent physician early in the stage a cure is likely to be effected.

(8) The mouth, tongue, and lip are frequent sites of cancerous growths. Cancers in these locations are curable in a rather high degree of instances.

(9) Cancer of the skin may develop, particularly in warts and moles, especially in the very dark colored moles. Warts and moles which change color or size should be regarded with great suspicion. Cancer of the skin may start as a benign lump. Pre-cancerous growths are frequent on the skin of elderly persons.

The last-named organs are the most observable and most accessible for treatment. Hence, if taken to a physician in time, cancers of those parts may be prevented or cured in a high percentage of cases.

Irritation as a Contributing Factor.—It is well established that cancer may be provoked to development in any part of the body which is subjected to long-continued irritation. Sharp-edged or jagged teeth fairly frequently irritate the tongue or cheek till cancer develops. Jagged teeth should be ground smooth by a dentist. Pipe stems which are rough or which become hot with use may contribute to the production of cancer on the lip. In certain sections of India the laborers in winter wear upon the abdomen pans or baskets which contain live coals. These people frequently suffer burns on the skin of the abdomen which sometimes lead to cancer on that part. Cancer in that area of skin is unknown among other peoples. Chinese men eat rice too hot and as a consequence frequently experience cancer of the esophagus; but their women, who eat cold rice at a second table, rarely develop cancer of the gullet. Warts and moles subjected to irritation may become malignant.

Cancer and Heredity.—White mice appear to inherit cancer through the generations. But white rats, rabbits, guinea pigs, and other animals experimented with show no such tendency. It is believed by some authorities that cancer in the human is not hereditary. Statistics

kept by life insurance companies indicate this belief to be correct. Yet there are a few who claim that a tendency toward heredity of cancer is found in some families. Whether cancer is hereditary in man is an unsettled question. Cancer is in no sense contagious.

Why People Delay Medical Attention.—It is said that only about 10 per cent of cancer cases come to attention of competent physicians in sufficient time to be saved, although the people are now being awakened to the great importance of the time element. One reason for delay in reaching competent physicians is that brought about by the patient's trying out the advertising cancer quacks who make extravagant promises, either directly stated or cunningly implied. Then, too, cancer usually starts as an insignificant-appearing, painless, slight enlargement of tissue. It is very insidious. It deceives the inexperienced. Furthermore, there is current in some localities an erroneous notion that cancer places a stigma upon the family. There is no reason whatever why cancer should be regarded as a stigma; yet this notion causes delay, and delay is fatal.

Precautions.—The following indications should serve as warnings: (1) lump in breast; (2) what appears to be irregular menses; (3) what appears to be " piles "; (4) irritation of tongue or inside of cheek by jagged teeth with consequent sores; (5) warts or moles which change color or size; (6) any continued irritation in any part of the body.

HAY-FEVER

In hay-fever the patient is *sensitive* or *hypersensitive* (consider the meaning of the term, *hyper-sensitive*) to substances contained in the pollens of certain plants. Frequently hypersensitivity is termed *allergy*. The terms are almost synonymous. Among the most frequently offending pollens are those of ragweed, Russian thistle (" tumble-weed "), Bermuda grass and timothy.

Nature of the Disease.—When the offending pollens—certain wind-distributed pollens—are inhaled by the person susceptible to hay-fever the proteins or other substances of those pollens are absorbed into the lining membranes of the nose and pharynx. The absorbed proteins are poisonous or toxic to those persons whose bodies are unable to tolerate them, and the swollen membranes of the nose and the excessive flow of mucus are the results of the poisoning. The irritating proteins not only cause the excessive flow of mucus but also cause the tickling sensation which produces the attendant sneezing.

The Skin Tests for Allergy (Hypersensitiveness). Patients of hay-fever may have skin tests made to determine which pollen is capable

of causing the poisoning. We may describe the tests: First, separate extracts are made of pollens of various plants which are blooming and producing pollen at the time of the year when the patient suffers from the disease. The extracts are made by allowing quantities of the pollens to remain for a period in separate containers of alcohol. Or instead of alcohol a mixture of salt water and glycerine may be used. During this period the proteins of the pollens become dissolved in the alcohol. These extracts are then injected with hypodermic needles into the skin of the patient (intradermally), not beneath the skin. The arm is usually selected as the site of injection. If the extracted protein, contained in the injected alcohol, causes poisoning of the skin, an angry, red ring about the size of a finger ring appears around the site of injection within a few minutes. The circle within the ring is white and much elevated. If the poisoning of the small area occurs as described, then it is known that the person's body is not tolerant of the protein. The person is then known to be sensitive to the pollen whose extract was injected. This is the pollen causing the hay-fever.

Desensitization.—When it is once known that a patient of hay-fever is sensitive to the protein of the pollen of a given plant, the physician may proceed to *desensitize* the patient in the following manner: An extract of the offending pollen, made in the same manner as described above, is injected beneath the skin (subdermally) in increasingly large doses for several weeks. The doses are given about 3 to 10 days apart. As the weeks pass the patient's body becomes more and more tolerant of the slightly increasing quantities of the toxic protein being injected. Finally, after several weeks the patient's body comes to be so tolerant of the protein that it may accept without visible response any amount of the offending protein which may be inhaled with the pollen of the particular plant. He is then said to be desensitized. The patient must be desensitized before each season in which the offending plant blooms.

Recently it has come to be accepted that substances of pollen other than proteins may cause hay-fever.

ASTHMA

Nature of the Disease.—Asthma is a case of hypersensitiveness. But instead of the nasal membranes being the chief site sensitized it is the lining membranes of the air passages in the lungs and the tiny muscles which run circularly in the walls of the small air tubes of the lungs. Also the muscles of the chest which perform the breathing

movements are sensitized. In asthma the tiny circular muscles of the air passages contract and thus reduce the size of the air tubes. This constriction of the air tubules results in decreased amount of air which reaches the lungs of the patient. Furthermore, in this disease the muscles of the chest which perform the breathing movements are more or less paralyzed, as a result of the effect of the protein on them. The effect upon these two sets of muscles is to reduce greatly the air received into the lungs of the patient. He complains of suffocation. Occasionally death results from the asphyxiation.

Causes of Asthma.—In many cases of asthma the cause or causes are not known in the present state of knowledge. Yet certain causes are known. Pollens may cause asthma, as well as hay-fever. Pollens, feathers, rabbit fur and horse dandruff are among the chief causes known. Volatile proteins or other substances emanating from the last three named stimulate the two sets of muscles mentioned above to contract and remain contracted for a prolonged period. In some cases of asthma, it is believed that the condition is provoked by bacteria in the body. Some authorities believe that the asthma is not due to the proteins themselves, but to some sort of substance or substances which are closely associated with the proteins.

It is possible to make skin tests with extracts of the pollens, feathers, fur, etc., to determine the cause of the sensitization, tests similar to those used for hay-fever. When the cause has been found, the person may be densitized in a manner similar to that used for hay-fever. Or, if the sensitizing agent is known, the patient may avoid further trouble by avoiding the offending agent. For instance, if feathers is the agent of sensitization, then the patient eliminates feather pillows from his home.

Influence of Heredity in Hay-fever and Asthma.—It appears that tendencies toward hay-fever and asthma are inheritable. Recently Balyeat studied the family histories of 1000 hay-fever and asthma patients. He found that 60 per cent of such patients stated that asthma and hay-fever existed in either their paternal or maternal lines or in both lines. On the other hand, he found that only 9 per cent of 1100 normal university students gave histories of those diseases in their antecedent lines. Other investigators have reported similar results.

ECZEMA

In this connection brief mention might be made of eczema. This is a type of hypersensitiveness which makes its manifestation in the skin instead of in breathing muscles or in the nasal membranes as in asthma

and hay-fever respectively. It appears that many cases of eczema are due to faulty digestion. Instead of certain kinds of proteins being digested in the normal way, they are split into substances which are toxic when absorbed through the intestinal wall into the blood stream. The toxin manifests itself by causing an inflamed condition of the skin. The offending proteins of the diet may be discovered by an elimination process or by means of skin tests with extracts of the various proteins of the diet. Among the most frequent offenders are eggs, wheat bread and milk. Sugar appears to increase the faulty digestion.

There is a close relationship existing between hay-fever, asthma and eczema, which relationship is not well understood at present.

PART II

PROMOTION OF PERSONAL EFFICIENCY: PHYSICAL, MENTAL, EMOTIONAL

CHAPTER VIII

WHAT ONE SHOULD KNOW ABOUT FOODS

Foods belong to two general classes—organic and inorganic. Organic foods are those which are formed by organisms, plant or animal, from inorganic substances. Animals possess but small capacity, practically negligible, for the formation of organic foods from inorganic substances. We may divide the organic substances used for foods into four classes: the carbohydrates, the fats, the proteins, and the vitamins. It will be noted that in naming these four classes of foods we have used the plural form in connection with each, for there are various kinds of carbohydrates, fats, proteins, and vitamins. We shall consider the four classes in the order named above.

I. THE CARBOHYDRATES AND THEIR SERVICES TO THE BODY

The carbohydrates are composed of three chemical elements: carbon, hydrogen, and oxygen. The carbohydrates may be subdivided into two sub-groups: the sugars and the starches.

(1) The Sugars. Among examples of the sugars may be mentioned dextrose (also called glucose and grape sugar), the chemical formula of which is $C_6H_{12}O_6$, and which is termed a monosaccharide or single sugar. As an illustration, dextrose is commonly found in fruits. Another sugar is saccharose (also called sucrose, or table sugar, or cane sugar) which has a chemical formula $C_{12}H_{22}O_{11}$, and is termed a disaccharide or double sugar, because its molecule has double the number of carbon atoms that those of single sugars possess. There are also triple sugars and even more complex ones.

Single sugars are absorbed through the stomach and intestinal walls without chemical change or digestion. The more complex sugars are all changed to single sugars, chiefly dextrose, in the digestive process. This change of the complex sugars into single sugars is accomplished in the small intestine by *enzymes* or *ferments* in the intestinal juice, which is formed within the intestinal wall and discharged into the intestine. There are three such enzymes in the intestinal juice. After

the sugars are converted into single sugars they are then absorbed into the intestinal wall and enter the blood stream. The blood distributes its single sugar content to the cells or tissues where they are needed for food.

Among the foodstuffs which possess dependable amounts of sugars are the following: molasses, syrups, honey, candies, fruits, sweet potatoes, and milk.

(2) **The Starches.**—The chemical formulas of the starches (Fig. 32) are not known. But what we might term the basic formula is the following: $(C_6H_{10}O_5)_n$. The various starches are multiples of this basic formula. What the n represents is not known.

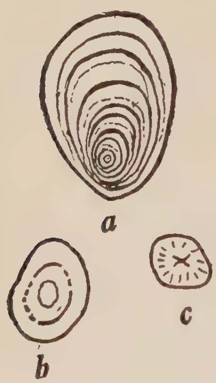

FIG. 32.

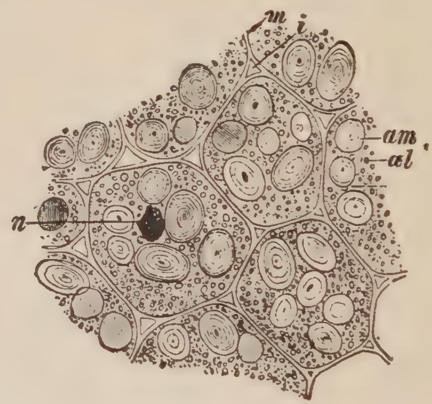

FIG. 33.

FIG. 32.—*a*, starch grain of Irish potato; *b*, starch grain of wheat; *c*, starch grain of corn. (Reprinted by permission from Martin's "Botany with Agricultural Applications," John Wiley & Sons, Inc.)

FIG. 33.—Section through a pea showing three cells entire and the oval-shaped starch grains within the cells. *am*, starch grain; *n*, nucleus of cell. (After Strasburger by Martin's "Botany with Agricultural Applications," published by John Wiley & Sons, Inc.)

In the digestive process all of the starches are converted into single sugars, for starches are insoluble and are thus incapable of being absorbed through the stomach and intestinal walls. The enzymes, or chemical substances which convert the starches to single sugars, are the ptyalin of the saliva and the amylopsin of the pancreatic juice. Most of the digestion of the starches is accomplished in the small intestine by the amylopsin.

Among the foods which possess starches in considerable quantities are Irish potatoes, sweet potatoes, bananas, corn meal, wheat flour, rice, oats, barley, and rye. The starch-containing foods may readily be recognized by their *starchy* nature.

Services of the Carbohydrates.—Some of the services performed by the carbohydrates for the human body are:

(*a*) The liberation of latent energy contained within their molecules. This energy is liberated in the form of heat energy and mechanical energy. The heat energy is that which we term the body heat. The mechanical energy is that energy which is used in locomotion and in the performance of physical labor.

The latent energy in the carbohydrates is released in the following manner: the carbohydrates are first digested, as described above. They are all converted into monosaccharides in the digestive process. The conversion of a disaccharide into a monosaccharide may be represented by the following:

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 2(C_6H_{12}O_6).$$

That is, a molecule of the double sugar together with a molecule of water may unite to form two molecules of single sugar. The single sugars thus formed are absorbed into the intestinal wall, then into the blood stream carried by the numerous blood vessels within the intestinal walls.

As related above, the blood transports the single sugars to the individual body cells where they are needed for food. The blood also carries oxygen from the lungs to the body cells. When the oxygen and sugars have arrived within a cell, a slow burning process, or *oxidation,* takes place. The oxygen unites with the carbon and hydrogen part of the sugar to produce carbon dioxide and water. In the chemical reaction occurring, heat and mechanical energy are produced, or released, just as occurs in the furnace of a factory, for instance. In the furnace, the carbon part of the coal unites with oxygen of the air to form carbon dioxide and at the same time energy is released which is utilized to run the machinery. In the furnace the coal, or whatever other fuel is used, must be heated to a certain high degree of temperature before the carbon and oxygen will unite. But in the case of the human body, enzymes bring about the union of the carbon of the sugar with the oxygen at a low temperature, much lower than is necessary for the union in the furnace.

The chemical reaction occurring in the cells of the body may be represented more or less accurately in the following:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6(CO_2) + 6(H_2O) + \text{heat energy} + \text{mechanical energy}.$$

(*b*) A second service which carbohydrates perform for the body is that if more carbohydrates are consumed than required for the body's

daily energy needs, then the excess carbohydrates are converted into fat and stored as fat, stored chiefly immediately beneath the skin and in the mesenteries of the abdomen. A small part of the excess carbohydrates consumed are converted into glycogen ("animal starch") and stored as such in the liver and muscles. The storage of excess carbohydrates is an emergency measure to provide food in time of famine or illness, for the fat and glycogen are called out of storage and oxidized in the cells in such times of need.

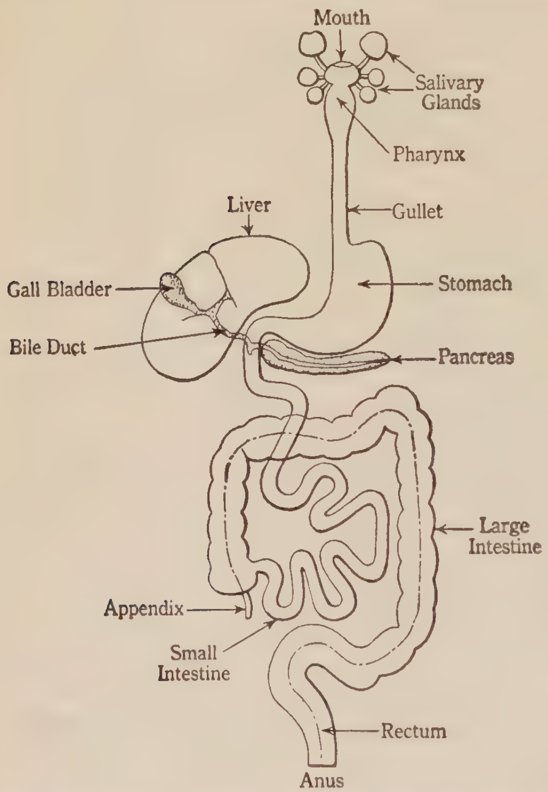

FIG. 34.—Diagram of the alimentary tract and its appendages. (Modified from Pearce and Macleod's "Fundamentals of Human Physiology," C. V. Mosby Co., after Testut.)

II. THE FATS AND THEIR SERVICES TO THE BODY

The fats are composed of the same chemical elements of which the carbohydrates consist: carbon, hydrogen, and oxygen. But the atoms of carbon, hydrogen, and oxygen are arranged differently in the fat molecules as compared with their arrangement in the molecules of the carbohydrates. The molecules of the fats contain many more atoms and are much more complex than those of the carbohydrates. Stearin, one of the simplest of the fats, has this formula: $C_{55}H_{104}O_6$.

Digestion and Absorption of Fats.—In the digestive process, which occurs chiefly in the small intestine, the fats are split into fatty acids and glycerine. That is, *lipase*, an enzyme of the pancreatic juice, splits the molecules of fats to form the simpler molecules of fatty acids and

glycerine. The glycerine is absorbed into the intestinal wall. Most of the fatty acids also are absorbed into the intestinal wall without further change. But some of the fatty acids first unite with alkalies of the bile and pancreatic juice to form soap, and in the form of soap are absorbed into the wall of the intestine.

Those fatty acids which unite with alkalies to form soap are released from their combination with the alkalies after being absorbed into the intestinal wall. Within the intestinal wall the glycerine and fatty acids re-combine to form fat. But they do not necessarily combine to form the same kind of fat as that of the original fat before the digestive process. The fat formed within the intestinal wall is transported by the lymph vessels (lacteals) from the intestine and is poured into the blood stream and distributed to the various portions of the body.

It is interesting in this connection to note that the kind of fat produced at the re-combination of glycerine and fatty acids in the intestinal wall depends upon the species of animal within which it occurs. For instance, supposing that a pig and a sheep are fed upon oats. When the fat contained within the grain is digested and re-combined in the intestinal wall of the pig, the fat which we call lard is produced, while that which we call tallow is formed by the sheep.

Articles of food which are rich in fats are butter, milk (cream) cheese, yolk of egg, fat portion of meat, nuts, cooking oils, and olive oil.

Services of Fats to the Body.—The services performed by fats for the body are the same as those of carbohydrates—the production of heat and mechanical energy; and storage as fat in the body, to be used as food in time of future need. Fats also furnish the body with Vitamins A and D, which are in solution in certain fats to be named later in discussion of vitamins.

III. THE PROTEINS AND THEIR SERVICES TO THE BODY

Chemical Composition.—The simplest proteins are composed of carbon, hydrogen, oxygen, and nitrogen. Thus all proteins possess one chemical element not found in carbohydrates and fats, the element nitrogen. Very few proteins are made up of those four chemical elements only. Most proteins contain sulphur also. Many proteins contain phosphorus. Other minerals which are contained in proteins and which are necessary to life are calcium (the chief constituent of lime), potassium, sodium, magnesium, chlorine, iron, and iodine. There are still other minerals contained in proteins, but perhaps they are not necessary to life. It is known that some of the minerals contained in proteins have special purposes for the body, which will be mentioned

later. From the above it will be seen that the protein molecules are far more complex than those of the carbohydrates or even those of the fats. The molecule of one of the simplest of the proteins is made up of the following: $C_{720}H_{1134}N_{218}O_{248}S_5$.

Foods which are rich in proteins include peas and beans, both white and yolk of egg, fish, the lean part of meats, and milk (casein is the chief protein in milk; it is the casein that clots in "clabber"), and cheese.

Digestion and Assimilation of Proteins.—In the digestive process, the proteins are split first into peptones and proteoses. This is accomplished by the enzyme, *pepsin*, contained within the gastric juice. The proteoses and peptones are then re-split by *erepsin*, of the intestinal juice, into *amino acids*. Proteins which escape being acted upon by pepsin in the stomach are split into amino acids by *trypsin* alone, of the pancreatic juice. The amino acids, therefore, are the simplest substances into which the proteins are split in the digestive process. The amino acids contain the nitrogen portion of the proteins, the radical NH_2. These acids are absorbed through the intestinal wall into the blood stream and are transported to the cells of the body where they are used.

There are several amino acids which are absolutely essential to life. They are the building stones out of which living matter or protoplasm is constructed. Different kinds of proteins vary greatly in nutritive value because some proteins contain more of these necessary amino acids than do others. Meat and milk come nearest to possessing all the amino acids needed by the body. Milk possesses all except glycin, which may be produced by the human body itself from other substances. Corn meal, peas, gelatin and beans do not possess all the necessary amino acids and an animal which is made to depend upon one of these food articles as its only source of amino acids dies. One should aim to get his daily supply of amino acids from several kinds of proteins so as to be sure of obtaining all the amino acids necessary for health and life.

Services of Proteins to the Body.—(1) Proteins are the only source of nitrogen and minerals which are needed by the growing body of the young for the building of additional tissue or living substance. But in the adult the amount of protein built into living tissue is probably very small, only such tissue being constructed from protein as is needed to replace worn-out tissue. (2) Most of the protein consumed by the adult body is used for fuel. Of course, protein is also used in the growing body for tissue formation. It is quite certain that some of the protein is converted into dextrose and perhaps glycogen before being

put to use as fuel. Thus one of the services of protein to the body is the same as one of those of the carbohydrates and fats, namely, that of being used for fuel in the production of heat and mechanical energy.

IV. THE VITAMINS AND THEIR SERVICES TO THE BODY

The chemistry of vitamins is unknown. However, a Japanese and an American recently have claimed to have isolated two of the vitamins, but their claims are doubted. Vitamins are not known by chemical methods of detection, but are known by animal feeding experiments. All knowledge of them has come from feeding of animals on restricted diets.

Vitamin A and Xerophthalmia.—Vitamin A is called " fat-soluble A" because it is supposed to be soluble in fats, since it is usually associated with fats, especially animal fats such as butter.

Function.—The absence or deficiency of Vitamin A in the diet produces a disease of the eyes known as **Xerophthalmia** (meaning, " dry eye "). A peculiarity of this disease is the cessation of the flow of the fluid secretions of the mouth, nose, throat, and eyes of the victims. In this diseased condition the tear glands cease to produce tears and the eyes become dry. One of the functions of the tears, which are produced in moderate quantities constantly in the normal eye, is to wash out bacteria getting into the eye. The bacteria are carried down the tear duct into the back portion of the mouth and on down into the stomach, where most of them are killed by the hydrochloric acid of the gastric juice. As a result of the drying of the tears the eyeball becomes infected with bacteria and ulcers are formed on the eye. When the saliva ceases to flow, the mouth and throat become painfully dry. Children suffering from this disease in the Far East make facial expressions as if weeping, though they produce but little sound, due to the exceeding dryness of the throat. It, as well as Vitamin B also, promotes growth in the young.

Sources.—Butter is one of the best sources of Vitamin A, as shown by animal-feeding experiments. Other good sources are whole milk, yolk of egg, and green leaves such as spinach, watercress, lettuce, celery leaves, turnip tops, beet tops, radish tops, and mustard greens which are popular in our Southern States. This vitamin is found in abundance in liver, kidney, and sweet breads, the latter being composed of the pancreas and thymus of the butchered animal. Vitamin A is not found in appreciable amounts in vegetable fats and oils.

Stability.—Vitamin A is not destroyed to a great degree by the heat of ordinary cooking. But it is reduced to some degree, though not to an

appreciable extent, by the exceedingly high temperature of steam pressure canning. This vitamin is found to be plentiful enough in foods mentioned above when they are cooked, canned, or when aged or dried.

Vitamin B and Beri-beri.—Vitamin B is also known as "water-soluble B," since it is found in solution in the watery fluids of plant leaves. Vitamin B was the first of the vitamins to be discovered.

Function.—Its absence or deficiency in the diet causes an inflammation of the nervous tissues and consequent paralysis, known as **beri-beri.** The disease is known chiefly in the Far East where the poor live almost wholly on polished rice. The outer portion of the rice grain contains the vitamin which prevents the disease, but the exterior part of the grain is removed in the refining of rice.

Historical.—Beri-beri was known among the Japanese as early as the second century B.C. In 1880 the Japanese navy was almost incapacitated because of the disease. A medical officer in the navy studied the disease. He changed the diet and caused beri-beri almost to disappear. Before the change in diet 32 per cent of the sailors developed the disease; after the dietary change only 0.6 per cent showed beri-beri. In 1897 a Dutch physician produced the symptoms of beri-beri in chickens which were for several weeks restricted to polished rice as their only food and this experiment has been repeated a number of times. The work of the Japanese and Dutch physicians thus demonstrated the absence of something in restricted dietaries not before suspected. In 1928 an outbreak of beri-beri occurred among the poor in the rice fields of Louisiana. Other outbreaks had occurred previously in that state, two in number.

Sources.—Sources of Vitamin B are tubers and root vegetables, leafy vegetables, fruits, cereal grains, peas, beans, and glandular organs of animals such as liver and kidney. It is especially abundant in spinach, turnip leaves, beet leaves, watercress, lettuce, and yeast, and is found to a considerable degree in cabbage, collards, and Brussels sprouts. Thus it appears that one could hardly avoid the inclusion of Vitamin B in the diet.

Stability.—Vitamin B is quite stable in the presence of heat. Even the excessive heat of steam pressure canning shows but little effect on the vitamin. Thus it is found in abundance in foods mentioned above when canned. Aging and drying of those foods do not reduce Vitamin B appreciably.

Commercial preparations proclaimed by loud advertisements as possessing abundance of Vitamin B are frauds because Vitamin B is found in abundance in wholesome foods. The grocery, not the drug

store, is the place to purchase Vitamin B, or any of the other vitamins.

Vitamin C and Scurvy.—Vitamin C is also known as the "water-soluble C" vitamin, being in solution in the juices of plants. It is furthermore frequently spoken of as the anti-scurvy or anti-scorbutic vitamin.

Function.—As already implied, the absence or deficiency of Vitamin C in the diet causes scurvy. Scurvy is a disease of the bones. It is characterized by loosening of the teeth in their sockets, this being due to the diseased condition of the bone of the jaws. But the most characteristic feature of the symptoms is the rupturing of small blood vessels in the skin, thus allowing the escape of blood into the tissues of the skin and giving the surface of the body a bloodshot appearance.

Sources.—Oranges, lemons, grapefruit, and tomatoes are especially rich in Vitamin C. Other foods containing this vitamin are celery, raw carrots, raw cabbage, lettuce, watercress, and most any other vegetable which can be eaten raw with safety.

Stability.—Vitamin C is the most unstable of all the vitamins. It is destroyed by heat of ordinary cooking, or by aging or drying. It is therefore not present in sufficient quantities in cooked, aged or dried foods. It is reduced to a great degree even by the heat of pasteurization of milk. Children who subsist chiefly or wholly upon pasteurized milk diet should be given orange, lemon, or tomato juice daily as a source of Vitamin C. It is of greatest importance that we carefully watch our dietaries to prevent any deficiency of Vitamin C. The destruction of Vitamin C by heat is an oxidative process. In factory canning oxygen may be excluded in the heating process and thus the vitamin may be saved.

Historical.—The history of the discovery of Vitamin C is interesting. In 1757 Dr. James Lind, a Scotch physician, wrote a book in which he stated that scurvy appeared among persons who were deprived of fresh raw vegetables and fruits for a period of about forty days. He knew the curative value of lemons for scurvy. After Dr. Lind's announcements Arctic explorers rationed their men with heated lemon juice, the juice being heated to sterilize it and preserve it. But the heated lemon juice did not prevent scurvy among the men, because, as we now know, the vitamin was destroyed in the heating process. Dr. Lind's announcement fell into disrepute and was forgotten until the year 1909 when Vitamin C was rediscovered. To cure scurvy the American Indians of the North soaked green pine needles or leaves in water and drank the water.

Vitamin D and Rickets.—Vitamin D is frequently spoken of as the anti-rachitic principle or vitamin. It is a fat-soluble principle.

Function.—The deficiency of Vitamin D in the diet of children produces a disease of the bones termed *rickets*. In case of the absence or deficiency of this vitamin the metabolism of calcium and phosphorus is interfered with. Since the normal metabolism of calcium and phosphorus is necessary for the unhindered development of bone, the deficiency of Vitamin D produces abnormal growth of the bones. Children who are victims are restless and irritable. Because of the softening of the bones the children do not walk or stand as early as normally. The muscles of the abdominal wall become weak and flabby and as a result the child exhibits pot-belly. In more advanced stages, the ends of bones enlarge, so that there come to be lines of knobs on the sides of the breast bone, due to enlargements of the ends of the ribs. The ankles become enlarged, also. The legs become bowed or knock-kneed. The head acquires superfluous bone and assumes a square shape. A rachitic child is more subject to infections, very frequently suffering from colds, influenza and bronchitis. Life is frequently brought to an end by pneumonia. Children may be made dwarfs by the deficiency of Vitamin D. It has been estimated that 50 to 80 per cent of the children in certain parts of the United States suffer more or less from rickets. It occurs most in children between the seventh month and the end of the second year of life.

Sources.—The sources of Vitamin D are the most limited of all of the vitamins. Only peoples who live largely upon fish have had an abundant supply of Vitamin D. This principle is most abundant in the liver oil of the codfish. Butter and the yolk of eggs are the only common foods which have been found to contain appreciable amounts of the vitamin. But these foods are much less effective than codliver oil.

In recent years it has been discovered that the ultra-violet rays of the sun promote the normal metabolism of calcium and phosphorus. Those rays produce Vitamin D in the skin. Therefore, the exposure of the unclothed body to sunlight may be made to take the place of Vitamin D received by way of food. But in this connection it should be remembered that most of the ultra-violet rays do not pass through the ordinary glass used for making of window panes. Hence sunlight passing through the panes of windows is of little effect upon rickets or its prevention. Frequently cases of rickets are treated with ultra-violet rays of artificial source. Expectant mothers and babies should be exposed in a judicious manner to rays of the sun, or should receive codliver oil under the direction of a physician. Babies are much less

susceptible to rickets when breast-fed, especially if the mother is in good physical condition and takes a satisfactory diet and sun baths or cod-liver oil.

Stability.—Vitamin D is quite stable with regard to heat or aging.

Vitamin E and Infertility.—This is sometimes called the "fertility" vitamin. Formerly this was called Vitamin X. It is fat-soluble, that is, it is found associated with fats.

Function.—It has been found that animals fed upon certain restricted diets containing all of the vitamins mentioned above are unable to produce young. That is, female rats fed upon such restricted diets are unable to carry their young till time for normal birth. They abort their young about two weeks before time. McCollum and his co-workers have found that the lack of Vitamin E in rats results in failure to assimilate iron, which in turn results in sterility. When ferric citrate, or the oil of the wheat germ, or liver fats were fed, the rats recovered and reproduction occurred in normal manner. Vitamin E is widely distributed in a variety of foods and it is believed not to be a cause of sterility in the human being.

FIG. 35.—Effects of sunlight on growth. These chicks had identically the same measured ration. But the one on the right hand was exposed to direct sunlight a half hour each day while the other was not. Which outdoor factor is most important for man's well-being, "fresh" air or sunshine? (Courtesy of Professor E. B. Hart, Wisconsin Agricultural Experiment Station.)

The P–P Principle (Vitamin G) and Pellagra.—It appears probable that the cause of pellagra is some sort of deficiency in the diet. Dr. Goldberger of the United States Public Health Service believes that the P–P principle, as he calls it, is a vitamin closely associated with, perhaps a fraction of, Vitamin B. Professor Sherman has recently proposed that the principle be called Vitamin G. However, it cannot be said that it has been definitely and finally demonstrated that the P–P principle is a separate vitamin. (The *P–P* stands for *pellagra preventive.*)

In pellagra there is a soreness of the mouth and tongue; diarrhea;

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a peculiar bronzing of the skin, only on exposed parts of the skin; and mental disturbances in the later stages.

Persons who are pellagrous are known to have subsisted on a restricted diet consisting of something like the following: refined corn meal, refined wheat flour, polished rice, sugar, molasses, fat cured pork, and corn grits. Dr. Goldberger has effected many cures of the disease by feeding of fresh lean meat, fresh milk, and fresh vegetables. More recently he has had excellent success in treatment of pellagra by the feeding of brewer's yeast, two to three teaspoonfuls daily. For prevention of pellagra Dr. Goldberger suggests fresh lean meat, fresh milk, fresh eggs, fresh fruits, and fresh vegetables, especially the leafy green vegetables.

A few years ago there were as many as 200,000 people suffering from pellagra in the United States, most of them in the South. Most new cases of pellagra appear in the spring of the year. Can this be explained? Does it have any relation to the winter diet?

To insure the presence of vitamins in the diet, we need to use fresh meats, especially liver; fresh milk; fresh eggs; fresh vegetables, especially the leafy ones; and fresh fruits. It is seen that all of the known vitamins are able to withstand the heat of cooking and canning and are able to endure aging and drying to a reasonably high degree, excepting Vitamin C. Vitamin C is not very resistant to aging, drying, and heating. Hence we must give particular attention to it in the balanced ration in order to make sure of its inclusion. Babies should be fed juices of orange, lemon, or tomatoes. Another of the vitamins to which we must give close attention in the formation of dietaries is Vitamin D, because of its very limited distribution in common foods. But it may be remembered that sunlight upon the exposed body may cause production in the skin of Vitamin D. Babies should be given codliver oil.

V. ORIGIN OF ORGANIC FOODS

All of the four classes of foods already discussed are organic foods. Plants originate organic foods, for animals possess almost no power for manufacturing organic substances. Animals, and man, may convert organic foods from one form into another but they cannot originate them. The ability and the inability to manufacture their foods forms the chief difference between plant life and animal life.

Carbohydrates are made by plants somewhat in the following manner: stomata or breathing pores on the under surface of the plant's leaf admit carbon dioxide from the air into the tissues of the leaf. There may be as many as two million breathing pores on the under surface of a single oak leaf. Water is received by the plant through its roots and passed up into the leaf. In the leaf is a green chemical substance called *chlorophyll*, which lends the color to the leaf. It is the chlorophyll which manufactures the carbohydrates. The water (H_2O) taken through the roots and the carbon dioxide (CO_2) taken from the air are first broken down chemically, that is, their chemical elements are split apart. Those chemical elements are then re-combined by the chlorophyll to form sugar:

$$6(H_2O) + 6(CO_2) \rightarrow \underset{\text{(dextrose)}}{C_6H_{12}O_6} + 6O_2.$$

There is thus an excess of oxygen, which passes out of the breathing pores. Enzymes within the plant may convert the sugar to starch by dehydrating:

$$\underset{\text{(dextrose)}}{C_6H_{12}O_6} \rightarrow \underset{\text{(starch)}}{C_6H_{10}O_5} + \underset{\text{(water)}}{H_2O}.$$

The starch may be stored in the seed, as in the case of corn or wheat; or in the fruit, the apple, for instance; or in the root, the sweet potato being an example; or in the stem, as in the sugar cane. The starch may be re-converted to sugar, as when the apple or sugar cane ripens.

But neither the chlorophyll nor the plant possesses the energy to perform the work involved in the manufacture of carbohydrates or the energy which is stored as latent energy in the foods. This energy comes from the sunlight, particularly the red and blue rays. Hence, there is no food made by the chlorophyll except in the presence of sunlight, either direct or diffuse light. We may say that the chlorophyll is the machinery which manufactures the food and the sunlight is the energy which runs the machinery.

It is not known exactly how plants make proteins and fats, but we are quite sure that they are made by building upon the carbohydrates already manufactured. The minerals and nitrogen which go into the making of proteins come from the soil through the roots. It is not known how vitamins are made.

Thus man and animals obtain their organic foods by consuming plants which have manufactured the foods and stored them within their bodies.

VI. THE INORGANIC FOODS AND THEIR SERVICES TO THE BODY

Sources.—There are at least three sources of inorganic foods or minerals: (1) minerals that are in solution in the fluids of plant and animal foods consumed; (2) minerals which compose a part of the proteins eaten; (3) minerals that are in solution in water which is drunk. The minerals which are essential to the body are the following: calcium, which is the chief constituent of lime; phosphorus; potassium; sodium; sulphur; magnesium; chlorine; iron; and iodine. Several other minerals are found in the body tissues but they appear accidental and non-essential. The minerals named above are constituents of the living matter or protoplasm of the body. They are also found in solution in the body fluids. One twenty-fifth of the body's weight is mineral and most of this is contained in the skeleton.

There are several minerals which have special purposes in the economy of the body and which are likely to occur in deficient quantities or which may suffer abnormal assimilation and utilization. Such minerals include iodine, calcium, phosphorus, and iron. We shall consider each of these in turn.

Iodine.—Most of the iodine of the body is contained within the thyroid gland. If iodine is deficient in the drinking water or in the diet the thyroid is unable to perform its function normally and the gland becomes greatly enlarged, which condition is known as goitre. Iodine is deficient in the foods which are grown in the Great Lakes region and the Rocky Mountain states. As a consequence goitre is quite prevalent among the people and animals of those sections. Experiments with animals have shown that goitre may be prevented by inclusion of iodine with the food. Cod-liver oil is rich in iodine and green vegetables of most countries possess moderate quantities. One or more cities of the goitre region have supplied iodine to the people by inclusion of the mineral in the city water. During the past year or two certain manufacturers of salt have put upon the market a salt containing iodine. But over-much iodine taken with salt occasionally produces an eruption on the skin.

Calcium and Phosphorus.—A disturbance of the assimilation and utilization of calcium and phosphorus produces rickets in the young child. Such disturbance of the metabolism of these two minerals is due to deficiency or lack of Vitamin D, as mentioned previously. And this metabolic disturbance results in abnormal development of the bones. Any derangement in the skeletal growth of a child is very serious and of fundamental importance to the well-being of such child.

Phosphorus is present in abundance in the average diet. Milk, eggs, and lean meats, fish, and a number of other foods are fairly rich in pnosphorus content. Therefore the inclusion of phosphorus in the diet is not a difficult problem. In fact, little or no thought need be given to tne diet with regard to inclusion of that mineral.

But very frequently the diet of man is poor in calcium, which is needed in relatively large quantities for the formation of bone and teeth, especially in the young. If sufficient calcium is not available to the young, either before birth or after, the teeth develop poorly and decay early. The expectant mother must be supplied with a diet which is relatively rich in calcium, for her blood must furnish calcium in quantities to the embryo for development of its bone and the initial development of its teeth. If her diet contains insufficient quantities of calcium, the calcium of her own teeth may be resorbed and conveyed to the embryo for its use. Hence it is frequently the case that child-bearing mothers experience decay of the teeth relatively early in life. The expectant mother also must consider the inclusion of Vitamin D in her diet in order that normal utilization of calcium and phosphorus may be maintained.

Milk is one of the richest sources of calcium for the diet. Cheese also contains large quantities of calcium, for much of the calcium of milk which is made into cheese is retained in the latter. It has been suggested that the expectant mother, who needs excessively large quantities of calcium for herself and unborn child, might supplement her calcium intake from milk with calcium carbonate, which is powdered chalk. The calcium carbonate may be mixed with table salt in the salt container.

Iron.—Iron is a necessary constituent of hemoglobin, which is a chemical substance on the surface of the red blood corpuscle and which lends the corpuscle its color. The hemoglobin of the red corpuscle while passing through the lung tissues becomes united in a loose chemical union with oxygen. The oxygen thus united with the hemoglobin is carried on the red blood corpuscle to the cells of the body. On reaching the cells the oxygen is released from its union with the hemoglobin and is taken within the cells where it is needed for oxidative processes. Thus a body which is deficient in iron is also deficient in hemoglobin and does not receive a sufficient amount of oxygen for oxidation in the cells. The result is an anemic condition. Such anemic condition frequently is found in infants and in young girls in adolescence. In such conditions iron in available form may be prescribed by the physician. It is probable that interference with the

assimilation of iron is experienced by those persons in whose intestines there is extensive protein putrefaction. Such extensive protein putrefaction may be produced in the intestines of persons who consume excessive quantities of protein foods or in the intestines of those whose digestive powers for proteins are reduced. Except for abnormal condition of the body, iron is found in sufficient quantities in many of the common foods. A number of common foods are richer in iron than are raisins—spinach, for example. So common is iron in the ordinary foods of the daily diet that we need give no special attention to the inclusion of this mineral, except in diseased conditions of the body, in which instance a physician should be consulted.

Water.—In a way water may be regarded as food. Water composes about 70 per cent of the weight of the human body. Water serves at least two purposes to the body: (1) It must be present for the oxidation and other chemical reactions to take place in the cells of the tissues. (2) Water serves as a medium for transportation. As the bulk constituent of blood, water transports oxygen from the lungs to the cells where needed for oxidation; it transports food in solution from the intestine to the cells; it transports carbon dioxide from the cells where oxidation occurs to the lungs to be passed outside the body; it transports urea and other waste products from the active cells to the kidneys where they are taken out of the blood; it transports heat and distributes it evenly throughout the body. A medium-sized adult person should consume a total of two to three quarts of water per day, this consideration to include that received in milk and beverages.

In selecting a balanced ration it is well to maintain a constant watch on the iodine and calcium content of the diet.

CHAPTER IX

HOW TO SELECT A BALANCED DIET

The Calorie.—The *calorie* is the unit by which the energy contained in foods is measured. When we speak of the calorie in relation to dietaries we always have reference to the *large* calorie. The large calorie is the amount of heat necessary to raise one kilogram (1000 grams or 1000 cc., equaling about one quart) of water one degree centigrade.

Caloric Values of Foods.—If carbohydrates are burned or oxidized inside the human body, they produce exactly the same number of calories of heat per given quantity as when completely burned or oxidized outside the body. The same statement is true of fats also. But this is not true of proteins, for proteins are not completely oxidized or burned in the body, as they are outside the body. In the oxidation of proteins as it occurs in the cells, urea (a compound and one of the split products of proteins) and other split products of proteins are not burned or split into their chemical elements but are carried by the blood to the kidney and passed out as a part of the urine. Since the urea and other fractions of proteins are not oxidized, not all the heat which is latent in protein is released when the protein is oxidized in the body. When burned outside the body proteins produce about 6 calories per gram, but when oxidized in the body they release only a little more than 4 calories per gram. Carbohydrates also produce a little more than 4 calories per gram when oxidized in the body. Fats produce slightly more than 9 calories per gram. Foods other than fats, carbohydrates, and proteins possess little or no caloric value.

Number of Calories Needed by the Body.—By means of certain complex scientific apparatus and machines it can be very accurately shown how many calories in foods a person is using in his body on a given day. The number of calories which one needs as food to supply the daily requirements for heat production and for mechanical energy depends upon such factors as the normal size of the body, the degree of activity in which it engages, and the amount of exposure to cold. It is found that a man weighing 150 pounds and engaged in sedentary occupation, such for instance as that of bookkeeper or average student,

uses something like 2200 to 2700 calories in food per day. That is, he uses that much energy to produce his body heat and his mechanical energy on the average day. The child needs more in proportion per weight than the adult, because of his great activity and because of increase in weight which must be produced; the large man needs more than the small man; the laboring man needs more calories than the man of sedentary occupation. A carpenter, for instance, of 150 pounds normal weight needs about 3500 to 4000 calories per day. The over-fat man who in the normal condition would weigh 150 pounds should have not more than 1400 to 1500 calories, in order that stored fat may be used up for oxidation purposes and his weight be thus reduced. A man who normally would weigh 150 pounds but who is underweight should consume about 3500 calories per day, providing his is a sedentary occupation.

Proportions of Foods in the Balanced Diet.—(1) *Proteins* should compose about 8 to 15 per cent of the number of calories taken per day. The growing child needs a larger percentage of protein than does the adult, for he must not only replace tissue that is being worn out but he must also provide additional tissue in growth. Perhaps 10 per cent of the calories in the daily diet is sufficient for the average college student, that is, for the college student of average activity. For the adult of sedentary habits 8 per cent perhaps will suffice. The average college student weighing 150 pounds should consume about 75 grams (2.5 ounces) of *pure* protein per day (beefsteak for instance is about 18 per cent pure protein, most of its weight being water) which produces about 300 calories. This would form about 20 per cent of the total weight of foods taken daily, weighed as they would when on the dining table.

But let us be reminded that no person should confine himself to a single kind of protein. In order to be sure of obtaining all kinds of amino acids necessary to life one should consume three or more kinds of protein foods daily. It should be remarked, however, that whole milk contains all amino acids necessary to life except glycin, which the human body is able to manufacture. But it is probably true that the average American consumes too much protein, especially of meats.

Proteins are oxidized in the body cells much faster than are fats and carbohydrates and thus they produce heat more rapidly. This fact together with the fact of the high caloric value of fats probably accounts for the unusually keen appetite which we possess for meats in very cold weather.

(2) *Fats* to the amount of 60 grams (2 ounces), yielding 540 calories, is probably something like the correct proportion for the average college

student or bookkeeper weighing 150 pounds, normal weight. This would form perhaps 5 per cent of the total weight of the food consumed in a day, considering it as it would weigh while on the dining table ready to be served. But the proportion of fats and carbohydrates with reference to each other is not of such great importance, provided we are sure that we are obtaining a sufficiency of the fat-soluble vitamins, which of course are contained in fats chiefly, and provided further that the fatty foods be not in excess. This proportion between the fats and carbohydrates is not of so great importance because the two classes of foods are utilized for nearly the same purposes in the body, excepting consideration of the two fat-soluble vitamins.

(3) *Carbohydrates* in the daily consumption of the average bookkeeper or college student of 150 pounds should amount to about 400 grams (14 ounces) of *pure* carbohydrate. That quantity yields approximately 1600 calories. And such a quantity probably would represent 70 to 75 per cent of the weight of the foods eaten, weighed in their condition at the time of serving. In this connection we should add that sugars possess the peculiar property of quickly satisfying the appetite, for they are readily dissolved or digested and absorbed through the intestinal wall into the blood stream. They appease the appetite before a sufficient quantity of wholesome food is taken. Hence our custom of partaking of the sweets only at the end of the meal is a good one with scientific reasons to support it. Of course sugars should not be indulged between meals, as is frequently done by young people especially.

Summarizing the above requirements relating to the proportions of foods in the daily balanced diet, we may offer the following table for the average sedentary person, including the average college student, of 150 pounds normal weight:

	Grams (*Pure*)	Ounces (*Pure*)	Percentage of total weight of foods eaten, as they weigh in their condition on dining table	Calories Yield
Proteins (*Pure*).....	75	2.5	20 per cent of weight of meal	300
Fats (*Pure*).........	60	2	5 per cent of weight of meal	540
Carbohydrates (*Pure*)	400	14	75 per cent of weight of meal	1600
			Total	2440

(4) *Vitamins.*—Vitamins are wholly essential to life. It will be recalled that in the discussion of vitamins in Chapter VIII, mention

was made of the fact that if the diet included fresh meats—especially liver; fresh milk; fresh eggs fresh; vegetables—especially leafy ones; and fresh fruits, we then should concern ourselves with only two of the vitamins: Vitamins C and D.

It was mentioned that Vitamin C is the most unstable of the vitamins. It is greatly reduced in the presence of heat, even the heat of pasteurization. Hence the young child fed on pasteurized milk should have the juice of an orange or lemon daily or juice of grapefruit. Or, such child might be given the juice of a tomato, supposing the tomato to have been ripe when picked from the vine, for tomatoes that are gathered when green and allowed to ripen by age possess but little vitamin content. Vitamin C is also greatly reduced in foods that are dried or aged, such foods as dried or evaporated milks, dried fruits, etc. Vitamin C is found in considerable quantities in the grasses upon which dairy cows feed in summer and the vitamin passes into the cow's milk. But in winter when the cow receives only dried grass or hay she receives but little of Vitamin C and it is found in her milk only in negligible quantities, especially in the latter part of winter. Children fed exclusively on either raw or pasteurized milk should be given juices of orange, lemon, or tomato.

To supply Vitamin C in a balanced diet it is necessary to include the following raw foods which contain either moderate or large quantities of the vitamin: carrots; lettuce; onions; rutabagas; lemons; oranges; limes; grapefruit; raspberries; bananas; pears; tomatoes; milk, unpasteurized. It should be remembered that the foods here named must be eaten raw to get the full benefit of all the Vitamin C content, since this vitamin is reduced or destroyed by heat, or rather by oxidation in the presence of oxygen which is promoted by heat. Some have claimed that canned tomatoes and canned strawberries retain a sufficiency of Vitamin C.

Vitamin D is the second of the vitamins to which we must give special attention in the formation of balanced diets. Especially is this true of dietaries planned for young children. As previously mentioned the deficiency of Vitamin D produces rickets in children, especially in those under five years of age. Vitamin D is the most limited of all the vitamins in its distribution. Of the common foods which contain moderate amounts only butter and the yolk of egg can be named. But the livers of cod-fishes are rich in Vitamin D and cod-liver oil is our richest source. Hence, it is well for the young child to be given this oil, under the direction of a physician. It will also be recalled that in the preceding chapter we mentioned the fact that the ultra-violet rays of the sun promote the assimilation and utilization of calcium and phos-

phorus for bone making. Therefore the sun rays, unobstructed by window panes, may be substituted for Vitamin D. The reason why so many young children during their first two years of life develop rickets to greater or less degree is probably because children during that period of life usually receive a minimum of sunlight.

Tablets have been widely advertised for sale in the drug stores and represented as containing a high vitamin content. During recent years a number of experiments have been made upon animals which show that such tablets are frauds. In each experiment in which animals were made to depend upon the tablets as their only source of vitamins, the animals died.

(5) *Minerals* are secured in the consumption of proteins, from the juices of plant and animal foods, and from water. Most of the minerals are in such abundance and so well distributed in the common foods that we need have no concern for them when formulating a balanced diet. *Calcium* is the mineral which is most likely to be deficient in common foods. The growing child or the expectant mother who is furnishing calcium to an unborn baby may suffer from a lack of the mineral from which bone and teeth may be formed. Therefore the child in its growth period and the expectant mother should receive liberal quantities of milk, for milk is rich in calcium. Occasionally persons need more *iron* than is being assimilated by their bodies, and this mineral can be supplied in available form with a physician's prescription. In some countries there is a deficiency of *iodine* in foods grown in those countries. This deficiency leads to the prevalence of goitre. Sections in our own country where there is a deficiency of iodine are the regions of the Great Lakes and Rocky Mountains. Persons living in these areas should see that young children are attended by a physician for the correction of the iodine deficiency. Iodized salt may be used to compensate for deficiency of iodine from natural sources, that is, from foods.

(6) *Water* should be consumed by the adult at the rate of about two or three quarts a day, the amount depending upon the degree of physical activity and upon the temperature. Water is a necessity for the chemical and physical processes occurring within the body and for preventing constipation.

(7) By *Roughage* we mean especially the leafy vegetables such as spinach, celery, lettuce, cabbage, turnip greens, beet tops, mustard greens, string beans, etc. These foods are bulky and woody and are for the most part undigestible. The *smooth muscle* fibers in the walls of the intestines are peculiar in that they respond very slowly to feeble stimuli rather than responding quickly to strong stimuli. They

differ in this respect from *striated* or *skeletal* muscles. The woody fibers of roughage prick the walls of the intestine and stimulate the smooth muscle fibers sufficiently to cause the peristaltic movements, which are slow waves of constriction of the intestines passing from the upper end of the intestine to the lower end. The mere weight of the undigested mass of roughage also urges the peristaltic movements. Thus the mass of roughage is carried down the intestine and sweeps out the latter as it proceeds. Therefore, woody vegetables tend to prevent constipation and the consequent auto-intoxication, which condition will be discussed later in this chapter. A large quantity of roughage should be consumed in each of several meals per week.

Variety is of utmost importance. We are prone to depend all too much upon meat, potatoes, and bread. These furnish calories, but they do not prevent constipation, nor supply the quantity of minerals and vitamins required for the best health. The average person needs more of the fresh foods—the leafy vegetables, fruits, milk, and fresh eggs.

Underweight.—Being underweight is a disadvantage to one's personal appearance. A more robust physique would enhance the personality. Since the time of Shakespeare, even since the time of Caesar, the person who possessed " a lean and hungry look " has had a reduced chance of success. Moreover, he is the more liable to become the victim of disease, his powers of resistance being lower than they might be otherwise. As a general proposition we may say that one should not be more than 10 per cent underweight, considering age, height, and sex, although there are some of small skeletal structure who may be a little more than 10 per cent underweight and still should feel no alarm.

Causes.—In some persons the digestive and assimilative powers are low by nature. But little improvement can be expected in the weight of such persons, even with the most careful and scientific feeding. They are organically defective. However, no one who is underweight should conclude that he belongs to this class without first making scientific and thoughtful effort extending over a period of several months to increase his weight. It sometimes happens that other persons suffer a reduction of their digestive and assimilative powers which were one time normal.

But most persons who are underweight are so from definite causes which can be remedied or removed, and when such causes are removed those persons increase their weight. There are several causes of underweight among this class of persons: (1) Such persons may be in the habit of eating a little between meals, rather than waiting till meal time when they might possess an aggressive appetite and be capable

and desirous of consuming a full meal of wholesome food. This cause of underweight applies in more cases of women than of men. Such persons are really underfed. (2) A cause of underweight in many, especially children and young people, is found in the fact that they do not eat sweets at the proper time, which is the latter part of meals only. Sugars possess the peculiar power of quickly satisfying the appetite, for they are dissolved at once and absorbed into the blood stream immediately and we no longer feel the hunger pain. After this satisfaction of appetite has been attained such persons then do not partake of more wholesome foods. Sugars furnish only calories; they do not supply the elements contained within proteins nor do they supply minerals or vitamins. This class of persons, also, are underfed. (3) Some do not exercise sufficiently to develop an aggressive appetite. An hour of tennis daily, an hour's fast walk, or other exercise which demands a similar amount of energy, will create a satisfactory appetite. (4) Still others do not consume sufficient quantities of carbohydrates and fats. These two classes of foods, when eaten in excess of the daily energy needs of the body, are stored in the body in the form of fat, provided the digestive and assimilative powers are not defective.

How to Increase the Weight.—Several of the measures to be taken for increasing one's weight are implied above in stating the causes of remediable underweight. Such measures for increasing the weight may be summarized here: (1) Avoid eating between meals. (2) Eat sweets only at the latter part of meals and at *no other time*. (3) Exercise sufficiently each day to develop a robust appetite. (4) Consume more carbohydrates and fats than needed for the day's energy output. (5) Drink one to two quarts of whole milk each day. Or, if one does not wish to drink so much, only the top halves of two quarts may be drunk, so as to secure the cream of both quarts. Some persons do not like milk. In that case one might flavor the milk with such flavors as are used at the soda fountain. Or, children may be induced to drink milk which is colored with food coloring used in the kitchen. (6) Follow practices in the daily routine of life that promote cheerfulness, which increases the digestive and assimilative powers. (7) Sleep seven to eight hours per day, maintaining *regular hours* for retiring and rising. In even moderately warm weather the bedroom should be well ventilated, preferably from two sides of the room, but not so as to produce a draft over the bed. In cold weather the room should be cold and in that case ventilation is not of great importance, as shown by the experiments of Flugge and his associates.

Preparations advertised for sale by drug stores and claiming remarkable powers for increasing the weight are frauds.

Overweight.—Obesity is inconvenient. It reduces one's efficiency in the performance of work and his chances of success in life. Consider old Sir John Falstaff and the price he paid for gluttony—perpetual exhaustion, suffering of contempt and vile epithets. To conceal his impotence in the face of work he resorted to lying. These are the portions and habits of all Sir Johns.

Over-fat persons carry such a heavy physical load that they have not sufficient energy remaining to perform the normal amount of work. The dread of moving deters the obese many times in the performance of work which otherwise would be done with alacrity. Most over-fat persons become so because they consume fats and carbohydrates in excess of the energy needs of their bodies. The excess is stored as fat beneath the skin and in the abdominal cavity. Such persons usually exercise too little. An occasional case of obesity, however, is pathological. That is, obesity with such an occasional person is due to some sort of diseased condition. But such persons are rare.

How to Reduce the Weight.—(1) Eat less of fats and carbohydrates than needed for the energy output of the day. This will necessitate the taking of fat stored in the body out of its storage and the oxidation of it for energy production. (2) Exercise fairly strenuously each day. After the carbohydrates and fats have been reduced in the diet this exercise will cause the oxidation of the fat of the body in order to provide the necessary energy for such exercise. (3) Eat bulky, woody vegetables in abundance, such as spinach, cabbage, celery, lettuce, turnip greens, mustard greens, etc. Such leafy vegetables possess very limited amounts of carbohydrates and fats and yet they satisfy hunger. They will satisfy the strong appetite resulting from the vigorous exercise and yet will not supply calories for energy nor produce fat in the body. Hence, at least a part of the energy used must come from oxidation of body fat.

But a *warning* must be given to the person who would reduce his or her weight notably. Fat burns or oxidizes in the body completely only when a carbohydrate oxidizes with it. If insufficient carbohydrate is present in the diet when the fat of the body is being oxidized rapidly, acid substances are produced by the incomplete oxidation of the fat and a less alkaline condition is developed in the fluids of the body. This reduced alkalinity of the body fluids is known as *acidosis* and is highly detrimental to the health. Therefore it is necessary that one consume a certain amount of carbohydrate for each given quantity of

body fat oxidized. It is unsafe to reduce the weight more than half a pound per day. It is safer to reduce under the constant advice of a physician.

The much advertised nostrums on the market for reducing the weight are wholly unreliable. If they contain nothing harmful or beneficial, they are frauds; if they contain ingredients which really cause the weight to decrease, such as extract of thyroid, then they are distinctly harmful. In recent years a nostrum widely advertised in the newspapers for reducing fat was found to contain *heads* of tapeworms. In the intestine a "head" becomes a full-grown tapeworm.

Constipation.—Severe headaches and general "bad feeling" may result from constipation. The exact cause of the headaches accompanying constipation is unknown. Some believe the headache to be due to toxins or poisons formed by intestinal bacteria from the splitting of proteins which have been delayed too long in the intestine. Others consider the headache to be due to excessive pressure exerted upon walls of the bowel by the excess waste matter contained in constipated conditions. The most stubborn cases of chronic constipation, unless they are caused by anatomical deformity of the intestine, may be relieved by drinking two or three quarts of water per day; by eating large quantities of woody vegetables and fruits, or consuming a large bowl of whole-bran daily, or a dozen or two dozen stewed prunes; by exercising vigorously an hour per day; and by establishing a toilet habit at a regular hour, preferably after breakfast or after the evening meal. It should be remarked that bran causes inflammation of the colon in some persons. Habitual use of cathartics is evil for the welfare of the body and to be discouraged. If, however, it becomes very necessary to use some sort of laxative, perhaps the best is mineral oil or a mixture of mineral oil and agar, which preparations may be had from drug stores. These preparations do not leave the bowel in an irritated, inflamed, exhausted condition. To leave the intestine in such a condition is a preparation for a succeeding period of constipation. Constipation may be a causal factor in auto-intoxication.

Auto-intoxication.—If for some reason undigested food remains overlong in the digestive tract, bacteria which live in large numbers in the intestine may attack the foods abnormally and split them into simpler chemical substances. Certain of such simpler putrefactive products of proteins are thought by some to be poisonous when absorbed through the intestinal wall into the blood stream and believed to produce the condition known as **auto-intoxication,** although this is not definitely proved to be the case. Drowsiness, headache, poor appetite, coated

tongue, biliousness and mental depression are some of the symptoms of auto-intoxication.

Overeating, especially of proteins, and excited or depressed emotions may occasion auto-intoxication. Abnormal emotions may delay the digestion so that the protein-splitting bacteria obtain an opportunity for their work.

Prevention of auto-intoxication lies in moderate eating, particularly with regard to proteins; avoidance of constipated condition; avoidance of mental depression and anger, and maintenance of cheerful outlook. Acidophilus bacilli, which are contained in milk or in tablets, and which may be had at drug stores, produce much lactic acid from certain sugars, especially milk sugar (lactose) which they ferment in the intestine. Protein-splitting bacteria are not tolerant of a strongly acid environment. Therefore, *Bacillus acidophilus* growing in large numbers in the intestine with lactose present, cause the extinction of the protein-splitting bacteria which, as stated, are non-aciduric. Thus, the cultivation of *Bacillus acidophilus* in the intestine is one of the modern remedies for auto-intoxication. But lactose must be taken with the *B. acidophilus*.

MALNUTRITION IN CHILDREN

There are two great factors or influences which produce, or fail to produce, well-rounded physical and mental human specimens. Those factors or influences are heredity and nutrition.

Definition and Symptoms of Malnutrition.—Malnutrition is "a low condition of health and body substance. It is measurable not only by height, weight, and robustness, but by many other signs and symptoms." The well-nourished child shows good color; bright eyes, with no blue or dark circles beneath them; smooth glossy hair; his step is elastic; he is usually happy and good-natured; extremely active, physically and mentally; and has a good appetite.

The malnourished child lacks several or all of the characteristics mentioned above for the normal child. His skin may be pale or muddy; dark circles may pass beneath his eyes; his hair may be rough, like that of poorly fed farm animals; his tongue may be coated; and his bowels may be constipated; his shoulders may be rounded, protruding forward; his teeth may be decayed; adenoids and tonsils may be enlarged or infected. He may not care to play; may be regarded as lazy; may lack mental vigor and power of concentration and attention; expression of eyes and face may be lifeless and dull; he may be irritable and difficult

to manage; and is likely to be fastidious about his food. He is likely 10 per cent or more below normal weight for his height and age and sex.

Prevalence of Malnutrition.—In New York City 171,000 school children were examined and 18.5 per cent were found to be malnourished. Dr. Thomas D. Wood estimates that between 15 and 25 per cent of our school children are undernourished. We are quite safe in saying that the percentage of school children who are malnourished in some degree is something around 20 per cent. This means that, as an average, there are one or more such malnourished children in each schoolroom.

Causes of Malnutrition.—(1) Among the causes of malnutrition we may mention *heredity*. But heredity accounts for only a small proportion of the malnourished, probably. Not much can be accomplished for those children born with weak powers of digestion and assimilation.

(2) *Inadequate diet.*—The diet of a malnourished child may be inadequate due to insufficiency. Economic conditions may account for the insufficiency or may not. The insufficiency may be due to the kind of food taken, to a lack of building material of protein such as contained in milk, eggs, fresh meat; iron for hemoglobin; calcium for bones and teeth; vitamins; roughage. Or perhaps the insufficiency is because of over-indulgence in sweets or because of indiscriminate eating between meals. The child should be given a generous diet. It requires many more calories in proportion to weight than does the average adult. And a larger proportion of its caloric intake should be protein than that of adults. The caloric requirements of children at the various age periods is shown in the following chart: [1]

	Calories per Day
Children of 1–2 years, inclusive	1000–1200
Children of 2–5 years	1200–1500
Children of 6–9 years	1400–2000
Girls of 10–12 years	1800–2800
Boys of 10–14 years	2300–3400
Girls of 12–14 years	2800–3300
Boys of 14–16 years	3400–4100

It will be recalled that the average sedentary man weighing 150 pounds requires 2200 to 2700 calories to furnish the day's energy. In the chart or table given above it will be seen that boys and girls in their early teens require even more calories than does the sedentary man of 150 pounds. This great caloric requirement is because of the great

[1] From "Text Book on Food and Nutrition," by American Red Cross, Washington, D. C.

activity of young people and because of the need of foods for developing additional tissue. The early teens is a rapid growth period.

(3) *Lack of sufficient sleep* is another common cause of malnutrition. School children should sleep from 9 to 12 hours, depending upon age and physical condition. The hours of sleep should be regular.

(4) *Fatigue* is still another cause of undernourishment. Very young children, including those of the lower three grades in school, should have two rest periods of 15 to 30 minutes each per day. If no better arrangement may be had, school children may have their rest periods on their desks, face downward.

(5) *Physical defects and disease* are among the most important of the causes of malnutrition. Enlarged adenoids and tonsils may obstruct the air passages of the respiratory tract, thus reducing the amount of oxygen available to the child in the cells of its body where oxidative processes occur. Or tonsils and adenoids may be infected with staphylococci or other germs of disease, which produce pus areas and much inflammation. Toxins from such infections may be absorbed into the blood stream and produce a general toxic condition or bacteria may be distributed through the body from such foci. Decayed teeth also may result in the production of toxic condition or may serve as a focus from which infections of other parts of the body may occur. Tuberculosis and syphilis are other causes of undernutrition. Bad teeth and tuberculosis may be the results of malnutrition as well as the cause of it.

(6) *Other causes* of undernourishment are lack of sunshine, lack of exercise, lack of healthy living conditions, undue excitement, and constipation.

(7) *Contributing factors of malnutrition*: (*a*) Poverty quite frequently is a contributing factor. Perhaps the low income of the parents does not permit a sufficient variety or quantity of food. Or perhaps the parents work long hours and the child is thus prevented from obtaining sufficient sleep. Some children possess physical defects or disease which are not attended to because of the poverty of the parents. Still another possibility is that both parents are compelled to work and as a result there is not sufficient parental control of the child's habits which affect its health. (*b*) Ignorance on the part of the parents with regard to proper foods for children and with regard to other matters relating to hygiene is a frequent contributing factor in the malnutrition of children.

Effects of Malnutrition.—(1) The *physical* effects of malnutrition are stunted growth, anemia, nervousness, irritability, and reduced energy. The malnourished child is inactive and usually declines to play; is list-

less and tired. Such a child becomes the man of poor health and reduced vitality. He possesses a low capacity for producing the anti-substances which combat disease germs or their products, and thus frequently falls a victim to infectious diseases, especially those of the respiratory group.

(2) The *mental* effects of malnutrition in children can not be so definitely demonstrated as the physical effects. Yet many experienced teachers are quite certain that malnourished children learn more slowly on the average than normal children. The poorly nourished ones are less attentive and their mental processes are slower. On the other hand, carefully conducted investigations in schools have failed to substantiate the beliefs of such teachers.

Treatment of Malnutrition.—The first step in the treatment of malnourished children is the finding of the cause or causes, which have been mentioned previously. The child should have a thorough physical examination by a competent physician. If poverty happens to be the cause then the aid of various relief agencies might be sought in correcting the child's physical condition. Perhaps the school lunch would solve the problems of such children. But the school lunch should be properly supervised by a person trained in dietetics so that children might receive the type of food needed by them.

Fresh-air classes and open-air schools have been offered as remedies for malnourished children. The author once saw an open-air school for undernourished children on the top of a skyscraper. At the time a terrific snowstorm was in progress. It is true that the schoolroom, if it might have been termed such, was walled-in on three sides and was covered. Such measures adopted for the purpose of correcting malnourishment in children are extreme measures. The children fare just as well physically when in a well-constructed schoolroom suitably ventilated by the window-gravity-exhaust method and properly heated.

Abundance of sunshine is important.

Nutrition classes are conducted as special classes in some schools for the instruction of children in matters of nutrition and health habits. The mothers are invited to attend such classes frequently.

Nutrition clinics are also held to which the parents of malnourished children may go for advice regarding the care of the undernourished child. Such clinics are conducted by physicians and nurses who are especially interested in children and nutrition. In some such clinics advice only is offered the parent, who is urged to take the underfed child to the family's physician. In other such clinics both instruction and treatment are given.

HOW TO FORMULATE A DAY'S BALANCED DIET

Given below are the successive steps to be followed in making out a daily balanced diet for one's self:

(1) Determine your weight and exact height, without shoes. Make record.

(2) Considering your weight, height, age, and sex, determine whether you need a fattening dietary or a reducing one; whether you should have one for a sedentary person or an active person; or whether you should have anti-constipation menus. (Refer to tables in Appendix A.)

(3) Calculate the total number of calories *you* need for one day, considering your activity and condition of weight.

(4) Calculate the number of calories which should be protein, say 10 per cent of the total calories for a young adult.

(5) Subtract the protein calories needed from the total number of calories needed. This remainder indicates the number of calories which should be carbohydrate and fat. The proportion of carbohydrates and fats with reference to each other is probably not of great importance, excluding the consideration of fat-soluble vitamins which the fats might contain. Perhaps it might be about as well to include the carbohydrate and fat calories together in a lump mass rather than to separate them and proportion each.

(6) Select the food articles desirable for the day; assign and apportion them to the respective meals.

(7) By reference to tables showing caloric values of the selected food articles, calculate the quantity of each food needed for each meal.

(8) Checking back through the tentative dietary, examine to find if the vitamins, especially C and D, have been included; to see if the minerals, particularly calcium and iodine (in iodized salt), have been given consideration.

CHAPTER X

REPRODUCTION AND SEX HYGIENE

Judge Ben B. Lindsey, for many years judge in a domestic relations court, asserts that one-fourth of the cases of divorce can be prevented with reliable information on matters relating to sex.

Reproduction in man is a very complex biological process. Perhaps we can better appreciate the complex human reproduction after a consideration of simpler processes of multiplication as it occurs among plants and animals. We shall first consider reproduction among the plants.

REPRODUCTION AMONG PLANTS

The lower plants, that is, the simplest plants, of the plant kingdom have the simplest methods of reproduction. As we proceed upward through the scale of plant life from the lower plants to the higher, from the simpler to the more complex, we pass from simpler methods of multiplication to more complex methods. We shall describe only four such methods, the three most common methods of the lowest plants and the most complex one among the highest group in the plant kingdom.

1. Simple Division.—We have previously described the simple division method of reproduction in connection with the discussion of bacteria, which are the simplest of the plant organisms. Simple division is also a common method among the algae (Fig. 4), which are tiny plants composing the green scums often seen on the surfaces of pools and upon the sides of trees and posts in rainy seasons. When an alga whose body consists of a single cell reproduces by this method the nucleus divides and the two parts separate. The cell wall constricts, growing inward between the two new nuclei. When the cell wall has completed its constriction, two cells are the result, the two from the one cell previously existing. The two cells break apart and separate, each becoming an independent organism or plant. Simple division may require only a few minutes or may occur once in a few days.

2. **A second method** of reproduction among the lower plants, among the multi-cellular algae, for instance, is that in which the plant grows an **egg.** The egg consists of a single cell; it is a female cell. The same plant may produce another type of reproductive cell known as the **spermatozoan** or **sperm** which is the male cell. The sperm swims about through the water, in which the alga lives, till it comes in contact with an egg. It appears to burrow its way into the egg, which is much the larger of the two. The nuclei of the two cells unite to form a single nucleus and the two cells thus become a single **fertilized** cell. This process of union of the male and female germ cells is known as **fertilization.** The fertilized cell divides after a few minutes, or a few hours, into two cells which remain attached to each other. The two cells then divide to form four cells which remain strongly attached together, and so on till a complete multi-cellular plant is produced. This young plant then produces sperms and eggs and the cycle thus starts over again. The sperms involved in the reproduction may come from the same plant which produces the egg or they may come from another neighboring plant. This is a *sexual method* of reproduction, that is, two sex cells unite to form a young plant.

3. **A third common method** of reproducing found among the lower plants is one in which a sort of egg or, more properly, a **spore** is produced by a parent plant. There are spores of different kinds or types among these lower plant organisms. The spore is capable of locomotion by means of hair-like *cilia* on its body surface which wave in the water to produce the motion. After separating from the parent plant the spore develops into a young plant, without fertilization. This is an *asexual* or non-sexual method of multiplication, since there is no union of sex cells occurring previously to the development of the young plant. Is simple division a sexual or an asexual method of reproduction?

4. **The most complex sex organs and processes of reproduction** are those found among the higher plants, those plants which we meet most in everyday life. Some of the higher plants have both male organs (anthers) and female organ (ovary) in the same flower, for the flower is the reproducing part of the plant. An example of this type of plant is the morning glory. Other kinds of plants have the male organs located in one kind of flower and the female organ located in another kind of flower, both types of flowers being on the same individual plant. The persimmon is an example of this type. Still another type of plant, represented by strawberry vines, has the male organs or flowers located on one kind of individual plant, known as a male plant; while the female

organ or flower is located on another kind of individual known as a female plant.

(1) *The Reproductive Organs of a Higher Plant.*—We shall describe the structure of the reproductive organs of a plant having both sex organs (anthers and ovary) in a single flower (Fig. 36). The outermost part of the flower consists of several green, leaf-like structures which served as a cover for the flower while it was still a bud. These structures are known as sepals, or all together they are known as the calyx. Inside of the calyx are several white or colored leaf-like structures known as petals, or collectively as the corolla. But the calyx and corolla have nothing fundamental to do with the reproduction. The essential parts of the flower are the several long **stamens** inside the corolla and the single elongated **pistil** located in the center of the flower. The stamens consist of a long stalk portion or **filament** and an enlarged upper end known as the **anther.** The stamens are the male organs and the **pollen grains** are produced in the anthers. The pollen grain contains a male cell or sperm. Hence, the anther is the essential part of the stamen. The pistil is the female organ. It consists of three parts: the enlarged upper end is the **stigma**; the elongated middle portion is the **style**; and the swollen lower end is the **ovary.** The ovary contains several **ovules,** inside of which are eggs.

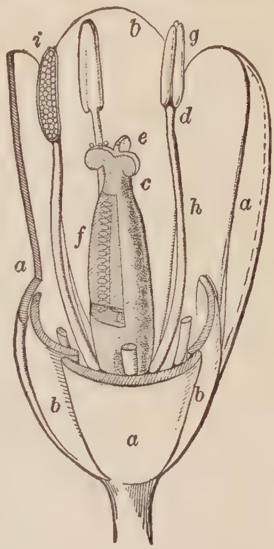


FIG. 36.—Structure of a flower. The outer set of covering leaves, *a, a*, is called the *calyx*; the single parts are *sepals.* The inner layer, *b, b*, is the *corolla*; its parts are the *petals.* The central organ is the *pistil*; the main body of the pistil, *f*, is the *ovary* and contains one or many little structures (*ovules*) capable of becoming *seeds.* The tip, *e*, of the pistil is the *stigma*; this is connected with the ovary by the *style c.* Surrounding the pistil are a number of *stamens*, *d*, consisting of a stalk, *h*, called the *filament*, and an enlarged capsule, *g*, called the *anther.* This contains a mass of cells which can be thrown out, *i*; these loosened cells are called *pollen.* (From Gruenberg's "Elementary Biology," Ginn & Co.)

(2) *Fertilization and Development of a Higher Plant.*—It has been mentioned that the anther produces pollen grains, in great numbers, and that each pollen grain contains a sperm or male cell. When the pollen grain falls upon the surface of the stigma, carried thither by insects or wind, the grain **germinates** (Fig. 37) being moistened by a fluid produced by the stigma and exuded upon the surface of the latter. As the pollen

grain germinates it sends a growing root-like structure downward through the stigma and style. This root-like structure is called the **pollen tube.** Within the pollen tube and keeping near its tip as the tube grows downward toward the ovary is the male cell or sperm which was within the pollen grain. The tube passes into the ovary (Fig. 38) and finally into an ovule, which contains an egg cell. The sperm enters into contact with the egg, and fertilization occurs (Fig. 39). The fertilized egg afterwards divides a number of times to form many cells. The resulting cells differentiate to constitute the parts of an **embryo** or

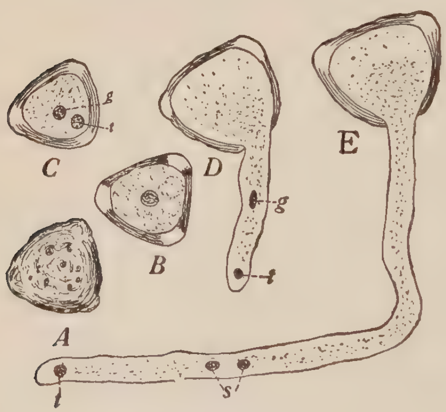


FIG. 37.

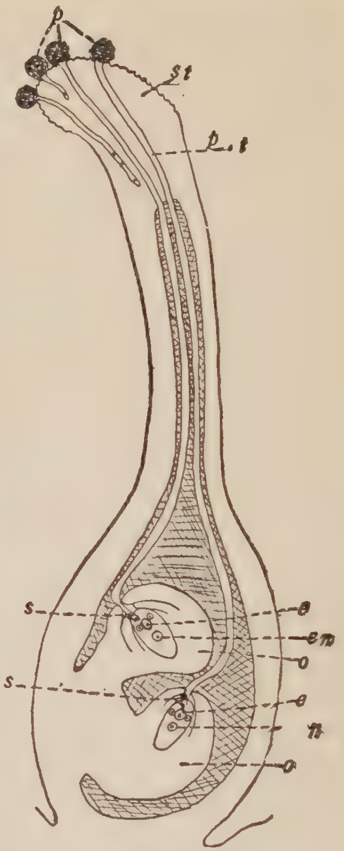


FIG. 38.

FIG. 37.—Pollen grains in different stages preparatory to fertilization. *A*, surface view of a pollen grain; *B*, section through pollen grain in uni-nucleate stage; *C*, section through pollen grain showing the nucleus divided into the generative (*g*) and tube nucleus (*t*); *D*, pollen tube forming into which the two nuclei have passed; *E*, tube more developed and generative nucleus divided into two sperms (*s*). Much enlarged. (Reprinted by permission from Martin's "Botany with Agricultural Applications," published by John Wiley & Sons, Inc.)

FIG. 38.—A diagram of a lengthwise section through the pistil of Red Clover, showing pollen tubes traversing the stigma and style. Two pollen tubes have reached the embryo sacs. *p*, pollen grains developing tubes; *st*, stigma; *pt*, pollen tubes; *o*, ovules; *e*, egg; *en*, endosperm nucleus; *s*, sperms. Much enlarged. (Reprinted by permission from Martin's "Botany with Agricultural Applications," published by John Wiley & Sons, Inc.)

young plant. The embryo is embedded in the seed (Fig. 40), as one may see by pulling apart the halves of a large bean after it has become

swollen by being in water for several hours. Under proper conditions of moisture, temperature, and oxygen the embryo plant simply enlarges to become a young growing plant. This, of course, is known as germination of the seed.

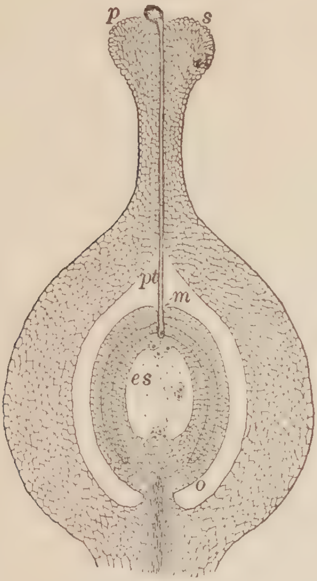


FIG. 39.

REPRODUCTION AMONG ANIMALS

Essentially the methods of reproduction in the animal world are the same as those among plants. We shall briefly review reproduction as it occurs among the lower animals.

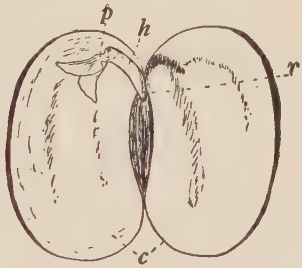


FIG. 40.

FIG. 39.—Fertilization in a flower. When a pollen grain, *p*, alights on the moist surface of a stigma, *s*, it absorbs water and puts forth a thread of protoplasm, or a pollen tube, *pt*, which grows down the style into the ovary. The tip of the pollen tube finds its way to the inside of the ovule, *o*, through a small passageway, the micropyle, *m*. The large cell in the middle of the ovule, called the embryo sac, *es*, undergoes a number of changes which result in producing several nuclei. One of these nuclei at the end nearest the micropyle corresponds to an egg cell. Similar divisions take place in the nucleus of the pollen grain, and one of the resulting nuclei corresponds to a sperm cell. The cell walls separating the pollen tube and the embryo sac dissolve, and the pollen nucleus unites with the egg nucleus. The newly formed joint nucleus, or fertilized egg, begins to divide. The embryo sac develops into a new plant, or embryo; the ovule becomes a seed; the ovary becomes a fruit. (From Gruenberg's "Elementary Biology," Ginn & Co.)

FIG. 40.—A bean seed showing the embryo and parts of same. *c*, cotyledons (containing food for the young plant); *h*, hypocotyl of the embryo; *p*, plumule (the leaf end); *r*, radicle (the root end of the embryo). (Reprinted by permission from Martin's "Botany with Agricultural Applications," John Wiley & Sons, Inc.)

1. **Simple Division** is also known as binary fission. It occurs as the regular method of reproduction among the Protozoa, one-celled animal organisms and the lowest and simplest of the animal groups. Simple division occurs essentially as it does among simple plant organisms, as already described. Among the Protozoa there are no males and females, all individuals being alike.

2. A second method of reproduction among animal organisms is that known as **Parthenogenesis.** In parthenogenesis the egg develops into a young organism without fertilization. Among the bees, for instance, all the eggs laid by the queen are capable of being fertilized but it happens that some are not fertilized. Such eggs produce the males or drones, notwithstanding the lack of fertilization. Among the wasps during the early part of the summer the eggs develop without being fertilized. The eggs of plant "lice," found on the under sides of leaves of garden vegetables, for instance, also develop parthenogenetically. Parthenogenesis does not occur among the higher animals nor in the human being.

3. **Hermaphroditism.**—Hermaphroditism (see Hermaphroditus in Greek mythology) is that condition in which both sex organs, male and female, are located in a single individual animal. Hermaphroditism is the normal condition among some of the lowest animal forms. Among the higher animals, and even in the human being, an occasional abnormal condition occurs in which an individual has both male and female organs. But in such cases one or both sets of organs are always rudimentary, that is, undeveloped.

(1) The tapeworm is an animal organism in which hermaphroditism occurs normally. In some species of these parasites there may be both the male and female organs within each segment or joint of its body, and there may be even several hundred segments. The worm's own sperms fertilize its own eggs, an example of what we might term *complete* hermaphroditic reproduction.

(2) That of the earthworm, or angleworm, is an example of what we might call *partial* hermaphroditic reproduction. Each earthworm has one set of male and one set of female organs, only one of each as compared with the many of the tapeworm. But a given individual earthworm can not fertilize its own eggs with its own sperms; it must receive sperms from another individual.

Among organisms exhibiting hermaphroditism there is only one kind of individual for each species. All individuals of the species are alike, each being both male and female.

4. **Among the higher animal groups and the human being** the two kinds of reproductive structures are associated with the bodies of two types of individuals, and we term those two types male and female. The sperms or spermatozoa are produced by the one, and the *ova* or eggs by the other.

Among the higher animals provision is made by Nature for the depositing of the spermatozoa by a **penis** in a **vagina** (meaning, "sheath") of the female. This is to provide greater certainty that fertilization

should occur, for the female of the upper animal groups produces only one ovum, or a few at most, once in an occasional period. Among the lower animal groups many ova, in some instances thousands per day, are produced with frequency. Hence, necessity for a special provision for insuring fertilization is not so great, both spermatozoa and ova being produced among the lower animal groups in almost unbelievable numbers.

Also among the upper animals and the human being there is a special provision of a **uterus** in the female for carrying, supporting, and protecting the fertilized ovum and the resulting embryo for comparatively long periods of time, for several months in cases of some species.

Among some of the groups (the birds, certain reptiles, and certain of the lowest mammals) the ova or eggs are laid or expelled from the body of the female within a few hours or a short period after fertilization.

With these general statements concerning reproduction among the upper animal groups we shall proceed to consider, with more detail, reproduction in man.

HUMAN REPRODUCTION

The Male Reproductive Organs.—The student is referred to Fig. 41. which should be thoroughly studied before proceeding further.

Two **testes** or testicles are located in the **scrotum,** a pouch of skin. Within the tissues of the testes are a number of greatly coiled tubules, known as **seminiferous tubules.** It is within these tubules that the spermatozoa are formed by being constricted off from certain cells in the wall of the tubule. The spermatozoan is elongated, consisting of a "head," which is mostly nucleus, and a "tail," which is vibratile and by which it has its motility. The spermatozoa are very active, appearing under the microscope to the casual observer something like the "wiggle-tails" or larvae of mosquitoes.

The **vas deferens** is a tube leading from the testis upward beneath the skin and over the pelvic bones into the abdominal cavity. There are two such tubes, one from each testis. These two tubes unite with the **urethra** a short distance from the point where the latter leaves the bladder. The vasa deferentia serve the purpose of conducting the seminal fluid and spermatozoa from the testes.

But before reaching the urethra each vas deferens enlarges into a sac-like *ampulla.* The spermatozoa pass from the testis up the vas deferens to the ampulla where they are stored temporarily, until expelled in

sexual congress or in nightly emissions. The spermatozoa were formerly thought to be stored in the seminal vesicles.

The **prostate gland** is a spherical body as large as a medium-sized marble. It surrounds the urethra just below where the latter leaves the bladder. The prostate secretes a fluid the purpose of which is obscure. But in the elderly male the prostate frequently is the site of infections or of cancer or may enlarge and so constrict the urethra that urination is difficult, sometimes impossible without artificial aid.

The urethra leads from the bladder to the end of the penis. It carries both the semen and the urine.

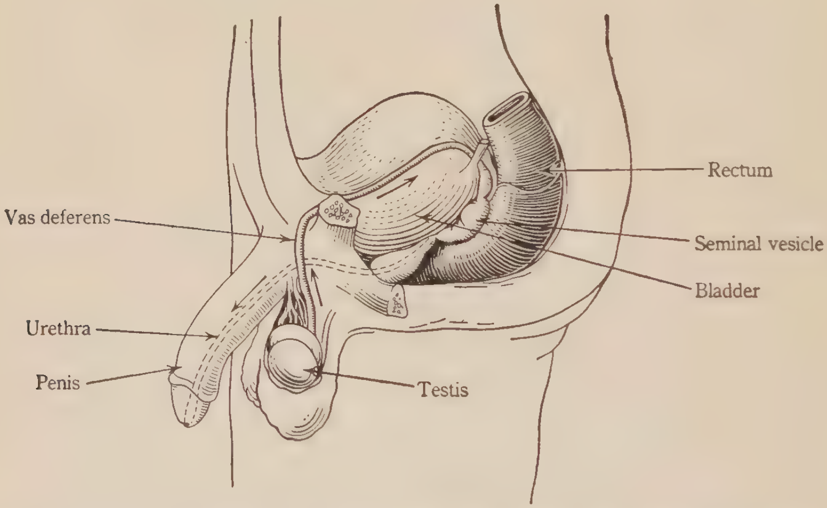


FIG. 41.—The male genitalia. The spermatozoa are formed in the testis and conveyed along the course indicated by the arrows. (Modified from Stiles' "Human Physiology," published by W. B. Saunders Co.)

The Female Reproductive Organs.—The student should first make careful examination of Fig. 42. It will be seen that the most centrally located of the organs of the female reproductive system is the **uterus** or womb. It will be noted that the lower end of the uterus protrudes into the upper end of the **vagina,** which extends to the exterior. It is further seen that at the upper end of the uterus are two tubes leading from the womb to either side. (Only one is shown in Fig. 42.) These two tubes are the **Fallopian tubes** or the **oviducts.** And just beyond the upper end of each oviduct is to be seen an **ovary**.

The vagina leads from the exterior to the uterus. It is a canal a few inches long and serves as a container for deposited spermatozoa. The

spermotozoa deposited are almost inestimable in number, something like 200,000,000 in a single time at sexual congress. This almost unbelievable number reveals Nature's anxiety for the perpetuation of her children. Usually there is only a single ovum produced by the female each month. Nature's hope is that some one of the vast number of spermatozoa will be able to make its way by its own motility from the vagina up through the uterus and into the Fallopian tube and fertilize the single ovum, for fertilization usually occurs in the upper half of the Fallopian tube.

The uterus or womb, as we have said, protrudes its lower end or *neck* into the vagina. The uterus is a tubular pear-shaped organ about

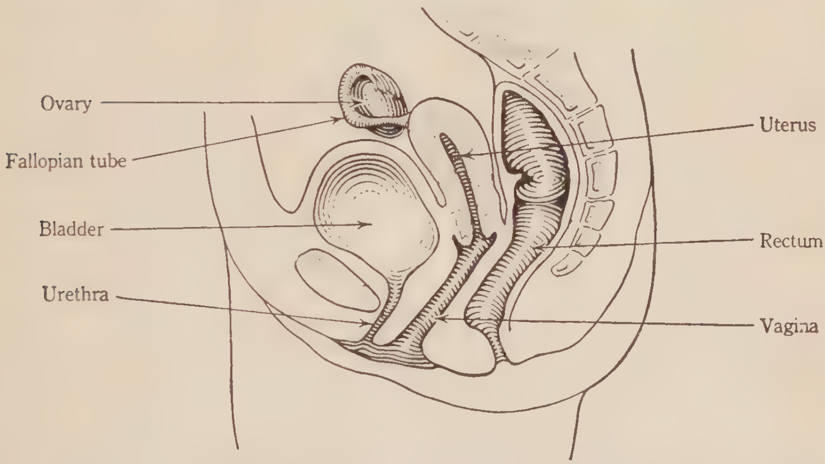


FIG. 42.—The female genitalia exposed by mid-section. (Modified from Stiles' "Human Physiology," published by W. B. Saunders Co.)

the size of a half-grown pear. It greatly enlarges during pregnancy. Its walls are very thick and muscular. The fertilized ovum passes down from the Fallopian tube where fertilization occurs, into the uterus and adheres to the wall in which it becomes embedded and where it develops into an embryo. The functions of the uterus are to serve as a receptive organ for the fertilized ovum and embryo, to protect and nourish, and finally its strong muscular walls serve to expel the child at birth.

The Fallopian tubes or oviducts serve to conduct ova from the ovaries down to the uterus. As already stated, fertilization usually occurs in the oviducts.

The two ovaries are attached to the posterior side of the abdominal wall. Their function is to produce ova. The ova are formed in the

ovaries of the child before its birth. At the time of the birth of a female baby there are from 100,000 to 800,000 immature ova in the two ovaries. But as the years pass most of these ova disappear, by dissolution and resorption. At 18 years of age there is a total of 35,000 to 70,000 ova present in the two ovaries. Of these only about 200 in each ovary ever reach maturity. Thus only a total of something like 400 ova are matured by the female during the period of her sexual life extending, in our country, from about the age of 13 to 45. Usually one ovum is matured each month, usually at some time within a week after menstruation.

The **Clitoris** is a small structure located just above the entrance to the vagina and slightly anterior to the female urethra. It is embedded in the tissues between the skin and the pubic bones. A study of the clitoris in a female embryo shows that this structure is really a rudimentary penis. It possesses erectile tissues, as does the male penis, and mechanical stimulation of it excites the sex impulse.

The Internal Microscopic Structure of the Ovary.—If one places a cross-section of the ovary under the microscope numerous **follicles** or minute cavities are seen. The ova are in the cavities attached to a stem which extends from the wall of the cavity outward into the center of the follicle. Besides this, a fluid is also in the cavity, filling the latter. There is usually only one ovum in a follicle. Usually only one egg is matured per month. The ovum at maturity is nearly as large as the head of a pin, being many hundreds of times larger than a spermatozoan.

Ovulation.—When an ovum is mature it is expelled from the ovary. This expulsion is known as **ovulation.** It occurs in a peculiar manner, the membranous cover of the ovary rupturing to allow the exit of the egg. After being expelled from the ovary the egg finds itself in the open abdominal cavity. Usually the ovum drifts with fluid drawn by motion of cilia into the funnel-shaped upper end of the Fallopian tube and passes down the tube to the uterus, as previously stated. Fertilization usually occurs in the upper portion of the Fallopian tube. But occasionally an egg does not pass into the oviduct but remains in the abdominal cavity where it may be fertilized by a spermatozoa which has made its way entirely through the Fallopian tube into the cavity of the abodmen. In such a case a surgical operation becomes necessary in order to save the life of the mother.

In case pregnancy occurs, either normal or abnormal, no ova are matured during the pregnancy nor usually for several months following birth of the child.

Menstruation is believed to be a preparation of the uterus for the reception of an ovum which is about to be expelled from the ovary. The menstrual period lasts three to five days normally. During the period the ovaries, oviducts, and uterus are much swollen and a portion of the inner lining membranes of the uterus sloughs off, resulting in some loss of blood. The *menses* occur about once in four weeks. The monthly sickness does not occur during pregnancy nor for several months succeeding the normal termination of a pregnancy. Neither does menstruation occur after the *change of life*, which usually occurs at about 40 to 45 years of age, when the ovaries cease their function.

Fertilization.—It has been mentioned that fertilization (Fig. 43) usually occurs in the upper half of the Fallopian tube. The ovum, whether fertilized or not, requires two or three days to pass down to the uterus, as it is believed. If the ovum is not fertilized it disappears within a few days, perhaps passes out the vagina. If fertilization occurs the ovum adheres to the wall of the uterus (Fig. 44). It becomes somewhat embedded in the wall, where it develops into an embryo. Most cases of fertilization occur within the first week or ten days following menstruation.

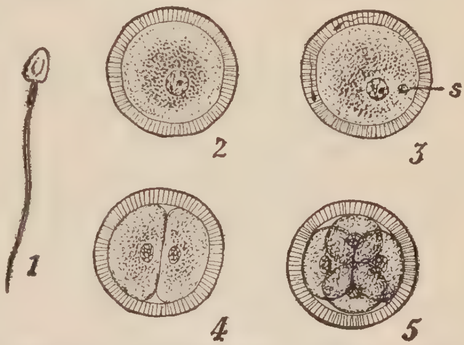


FIG. 43.—1, A spermatozoön or male germ-cell highly magnified. 2, An ovum less highly magnified. It has a rather conspicuous envelope, the *zona pellucida*. 3, An ovum which has been exposed to the sperm, *s*. The half-nucleus derived from the head of a spermatozoön which has entered the interior of the egg and will soon unite with the half-nucleus already present. With the union of the two fertilization will be accomplished. Two additional sperm-cells are arrested in the capsule. 4, Two cells which have arisen by the cleavage of the fertilized egg. They are still within the old envelope. 5, The four-cell stage. (From Stiles' "Human Physiology," W. B. Saunders Co.)

Stages in Development of Embryo.—Soon after fertilization occurs in the Fallopian tube, probably within an hour, the fertilized egg-cell divides to form two cells (Fig. 43). Soon again the two cells divide to form four, and these in turn divide, and so on continuously. By the time the young embryo reaches the uterus in its descent of about two days the mass consists of a few hundred cells.

On reaching the uterus the embryo adheres to the wall of the uterine cavity and becomes embedded there, as previously stated. It develops a mat of root-like structures which grow into the tissues of the uterine

wall. This dense net of root-like structures develops blood vessels from the young embryo and these vessels come into very intimate contact with the mother's blood in the tissues of the wall of the uterus. The embryonal blood receives oxygen and food from the mother's blood and gives up to the maternal blood carbon dioxide and other waste products of its own metabolism. This dense mat of blood vessels and tissues is disc-shaped and is known as the **placenta.** The placenta serves as a meeting ground of the embryonal and maternal bloods, though a mixing of the two bloods does not actually take place. It serves as an organ of exchange, for exchange of food and waste products between mother and embryo. The exchange takes place by filtration and diffusion through the walls of the blood vessels. Within a few days after fertilization the embryonal part has been formed and it drives the embryonal blood through the vessels contained within the **umbilical cord** to the placenta and returns.

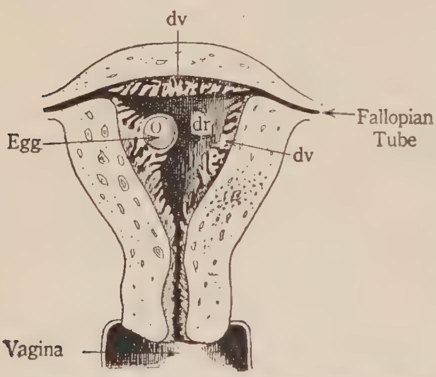


FIG. 44.—Implantation of the fertilized egg in uterus. (From Kinberg-Von Sneidern and Sundquist's "Sex Hygiene," published by Henry Holt and Co., New York.)

The Fetus.—At about seven weeks after fertilization the embryo has become fairly human in appearance, having developed the eyes, nose, ears, and face and having to a considerable degree straightened its neck region which formerly was much curved. After the twelve-weeks stage it is no longer spoken of as an embryo but as a *fetus.*

The Membranes and Fluid.—While still in the embryonic stage two membranes, known as the **amnion** and **chorion,** are developed to surround the embryo. The embryo is thus within a sort of double-layered pouch or sac (Figs. 45 and 46). Fluid fills this membranous pouch, so that the embryo is actually floated or buoyed up in the fluid. The flotation serves to protect the young organism from shocks and mechanical injury. The fluid is spoken of as the **amniotic fluid.** The double-layered membrane continues to grow in size during the fetal stages until it entirely fills the uterus and the outside surface of the membranes become fused with the lining membrane of the uterine wall.

Birth of the Fetus.—Birth occurs about nine months after fertilization. Several hours prior to birth of the baby contractions of the strong mus-

cular walls of the uterus cause the so-called **labor pains.** Such contraction of the uterus produces a rupture of the membranes surrounding the fetus, and allows the more or less clear amniotic fluid to escape by way of the vagina. Finally the uterine contractions grow sufficiently

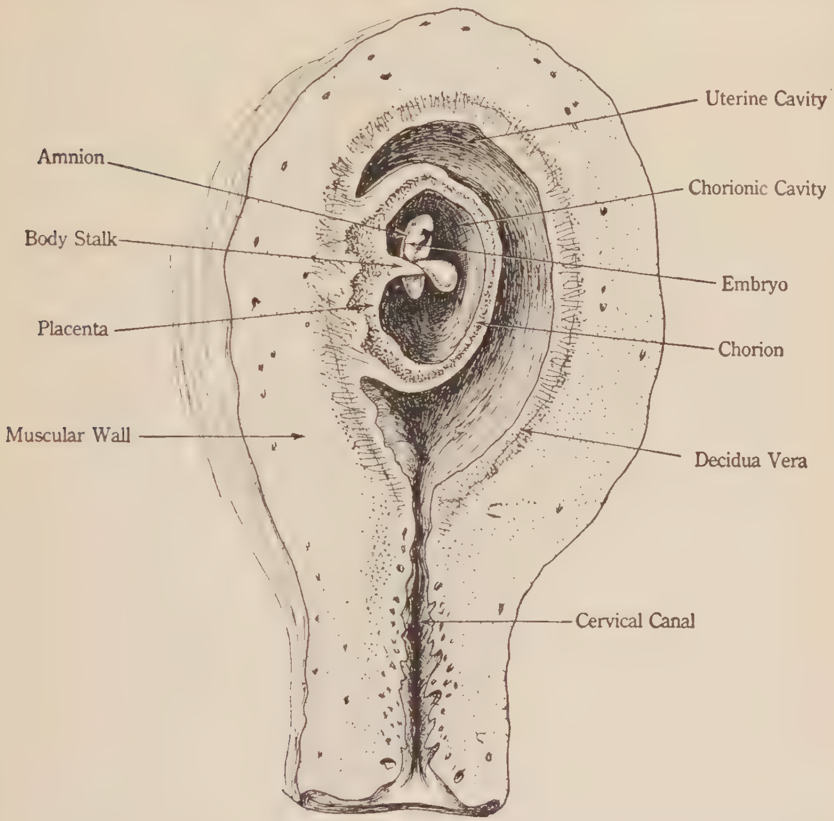


FIG. 45.—Pregnant uterus of about one month, longitudinal section. (Modified from Prentiss and Arey's "Textbook of Embryology," W. B. Saunders Co.)

strong to expel the child, usually head first. The umbilical cord is then cut and tied to prevent loss of blood. The navel is the permanent scar left at the base of the cord. For some time after the birth continued uterine contractions cause the sloughing of the placenta and the enveloping membranes which had become fused with the wall of the uterus. When the fused membranes and placenta are sloughed off many small blood vessels are ruptured with considerable loss of blood.

This sloughed material is passed out through the vagina and is known as the **after-birth.**

The Crisis of the New-Born.—The new-born experiences the greatest physical crisis in all its life between the time of fertilization and

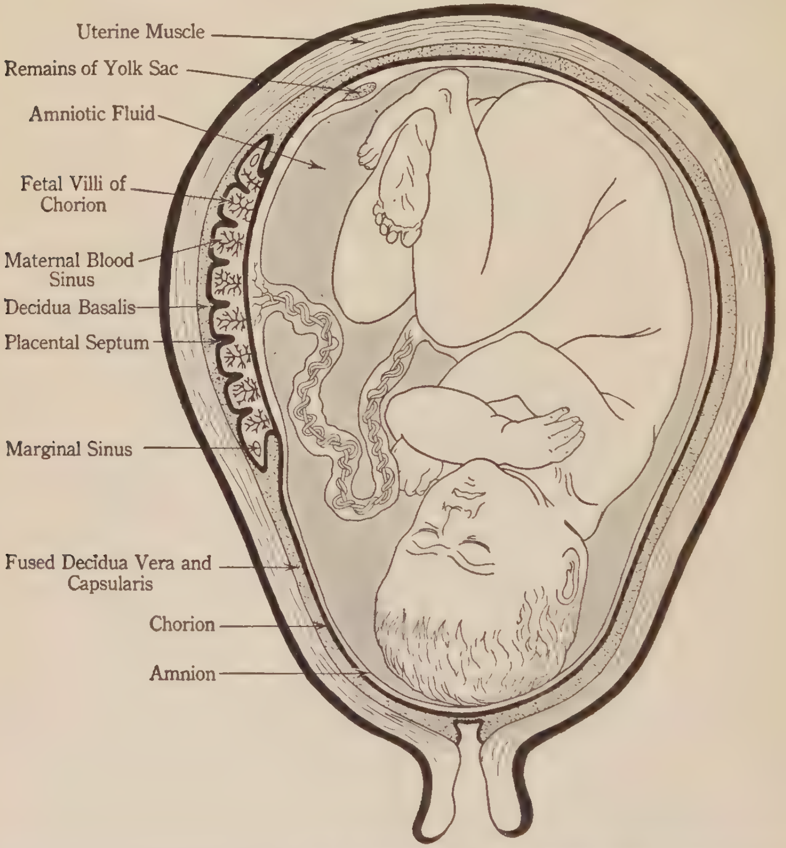


FIG. 46.—Section of the uterus, showing the relation of an advanced fetus to the placenta and membranes (Ahlfeld). Amniotic fluid fills that portion of the cavity of the amnion not occupied by the fetus. When labor of birth begins the strong muscles of the uterus contract and force the head of the child against the membranes (chorion and amnion) at the mouth of the uterus sufficiently strong to rupture those membranes. As the membranes become ruptured the amniotic fluid flows out through the vagina. Further contractions of the uterus force the fetus through the mouth of the womb and through the vagina, head foremost in the normal case. The cord is then tied and cut. Later the uterine contractions cause a sloughing off of the placenta, the decidua and the chorion and amnion, all of which are known as the "after-birth." When the "after-birth" is sloughed off there is considerable loss of blood from the wall of the uterus. The "after-birth" weighs between one and two pounds. The placenta is a disc an inch thick and about 6 inches in diameter. The cord is about 2 feet long. (From Prentiss and Arey's "Textbook of Embryology," W. B. Saunders Co.)

final death of its body. The new-born can no longer depend on the mother's blood to supply it with oxygen and food. It must perform its own respiratory movements and often it fails to do this. After the cutting of the cord the babe must change the course of its blood; it must cease to send its blood through certain embryonic vessels and must send it through certain other blood vessels which hitherto have been but little used. This phenomenal change in the circulation itself constitutes a crisis of great hazard, and not a few new-born babes fail to meet the crisis successfully.

Puberty.—The attainment of sexual maturity is known as *puberty*. The age of puberty occurs usually between the ages of 12 and 16. It occurs a year or two earlier in girls than in boys. Full maturity is not attained at once; it requires a few years. As the boy attains the age of puberty great changes occur in his body. Rapid growth occurs; his voice changes pitch due to enlargement of the larynx and lengthening of vocal chords; hair develops on the face, in the arm pits, and on the pubes; the generative organs enlarge; and seminal fluid is secreted, which may be emitted occasionally at night during voluptuous dreams. These nightly emissions are entirely natural and they usually occur once in two weeks to once a month or even less frequently. The boy may suffer profound psychic experiences during the adolescent period. The temperament may be decidedly unstable. His moods may fluctuate between peaks of high spirits and depths of despair; profound nervous disturbances may occur. Even suicide may be contemplated. As the age of puberty is approached the boy should be instructed in sex hygiene and in matters regarding venereal diseases.

As the girl reaches puberty the hips enlarge, due to growth of the pelvis and the development of subcutaneous fat tissue; the breasts enlarge; hair appears in the arm-pits and on the pubes; the generative organs enlarge; ovulation occurs and menstruation begins. Young girls should be taught by their mothers to expect the menstrual period in order to prevent undue excitement when the menses appear.

Cessation of Sexual Life.—In the female the reproductive period usually ends at about 40 to 50 years of age. The period is spoken of as the *menopause* or *climateric* or "change of life." Women in the menopause usually show irregular menses and scanty flow. Or the flow may be more constant. In the latter case a physician should be consulted, since the effects of cancer of the uterus may be mistaken for the menopause. The change of life is a serious period in the lives of many women and such women should be under the close observation of

physicians. Not a few women in this period of life suffer mental disturbances, in many cases this being due to lack of proper care.

The cessation of the man's sexual life is much more indefinitely known than that of woman's. But recently a physician who has investigated a few dozen cases asserts that most men no longer produce spermatozoa when they reach the age of 60. Newspapers have published stories of men more than 100 years of age possessing young children. Some of these published recently have been investigated and doubt is expressed as to the truth of the claims. In one case made famous by the newspapers, the case of a man claiming to be 130 years old, it was shown that his age had been misrepresented to the extent of 20 or 30 years and evidence was obtained which indicated that his alleged child by a middle-aged wife was illegitimate.

Death.—The exact cause or causes of the death of the human body are not known. After mid-life begins retrogression of the cells and tissues. They slowly approach death. All the tissues and organs are approaching death. They become more and more impotent and helpless. Finally one organ or system fails—and they all fail. Not knowing the cause of death we can not escape it. Certain it is, however, that man dies as a price for his highly differentiated and specialized body. The protozoa, the simple one-celled animal organisms, multiply by each dividing its body into two organisms which separate and become independent. These two later divide into four which go their separate ways in life. The protozoa never die, except by occasional accident. Each individual protozoan is potentially immortal. It lives continuously and forever. Of man's body only the germ-cells or reproductive cells are potentially immortal, those germ-cells which find their complements live on and on through the ages. But man's body-cells are highly specialized for specialized duties. For the privilege of specialization they pay the price. They forfeit immortality; they die. Yet the object and goal of the human body is not death. The biologist sees " through a glass darkly," it is true, yet he sees through the mysterious veil of life sufficiently to observe that the whole object and purpose and endeavor of a plant or of an animal body are expended directly or indirectly for the welfare of the next generation of its kind. The young plant germinates, lives, makes food, stores it in the seed for future use of the tiny embryo therein, then dies. So with the human being. Our bodies are born to labor a few numbered days for those bodies to come after us. The better the care of these, the better will be those to come.

Hormones of the Sex Glands.—By the term sex glands, we of course refer to the ovaries and testes. A **hormone** is a chemical substance produced by a gland and passed into the blood stream. The hormone may produce a co-ordinating effect upon a distant part of the body. Hormones supplement the nervous control of the body by causing different parts to co-ordinate in certain processes.

The testes appear to produce at least two hormones. The one appears to impart stamina, endurance, and ambition to the male body. Compare, for instance, these characters in the stallion and in the gelding, or in the bull and the steer. The same comparison may be made between the normal man and one castrated, a eunuch. The latter is more submissive and possesses less endurance for hard labor. The second hormone of the testes causes the sexual development which we term puberty, already described. It is responsible for the sexual impulse.

The ovaries also possess a hormone which causes sexual maturity and its attendant feminine characters. A second hormone of the female sex glands promotes the welfare of the embryo in the following manner: When an ovum is expelled from the ovary and duly fertilized it clings to the wall of the uterus, as already described. After fertilization takes place a firm spherical mass of tissue develops in the space vacated in the ovary by the expelled ovum. This mass of tissue is termed the **corpus luteum.** The corpus luteum develops only in case of fertilization and impregnation of the ovum in the wall of the uterus. Now, the corpus luteum secretes a hormone which causes the growth of the breast in pregnancy. It may be remarked here also that it appears that a hormone is secreted by the fetus and given to the mother's blood which prevents the formation of milk in the enlarged breasts. But this inhibiting influence is removed with the birth of the child and the breasts are then free to produce the milk.

The Chromosomes of the Body-Cells.—In order that an elementary understanding may be had of what determines sex in the progeny and the method by which characters are inherited from the parent by the child, it becomes necessary first to give some attention to the internal structure of the nuclei of cells of the human body. In the nuclei of the *body-cells* of the human being are 48 tiny bodies, most of them oblong in shape, known as **chromosomes.** The chromosomes are arranged in pairs. There are thus 24 pairs. Of these 48 chromosomes, 23 pairs are of practically the same size and shape and they are known as *ordinary* or *regular* chromosomes. But the remaining pair are known as the *sex* chromosomes because they contain the characters, maleness or

femaleness. In other words, this pair of chromosomes are the bearers or transmitters of something relating to sex. There are thus 46 ordinary chromosomes and 2 sex chromosomes in the body-cells of the human being.

In the female the two sex chromosomes appear exactly alike under the microscope, when the cells are stained after a certain manner so as to reveal the chromosomes in the nuclei. But the sex chromosomes in the body-cells of the male are quite dissimilar, in shape and size. One is much smaller than the other. The larger one is called the X-chromosome and the smaller is known as the Y-chromosome. The X-chromosome in the male body-cell is the same in size and shape as the two sex chromosomes in the female's body-cells. Hence, the female body-cell is said to have 2 X-chromosomes. There are thus 46 ordinary chromosomes and 2 X-chromosomes in the body-cells of the female; while in the body-cells of the male there are 46 ordinary chromosomes, 1 X-chromosome, and 1 Y-chromosome.

Chromosomes of the Germ-cells.—When ova are formed in the ovary of the female body a single cell in the ovary divides to form two ova. One member of each of the 24 pairs of chromosomes in the single cell passes into one ovum and the other member of each pair into the second ovum. Thus in each human ovum there are 24 chromosomes, unpaired. That is, there are 23 ordinary chromosomes and one X-chromosome (Fig. 47). Thus all ova are alike with reference to number and kind of chromosomes contained.

When spermatozoa are formed in the seminiferous tubules of the testis, four spermatozoa are formed from a single cell in the wall of the tubule. This single cell, it will be recalled, contains 23 pairs of ordinary chromosomes and 2 other chromosomes unpaired, one of the latter being known as the X-chromosome and the other as the Y-chromosome. The four sperms are formed in such a way that each receives 24 chromosomes, unpaired. However, two kinds of sperms are produced. One kind receives 23 ordinary chromosomes and the X-chromosome; the second kind receives 23 ordinary chromosomes and the Y-chromosome (Fig. 48). The two kinds of spermatozoa are produced in exactly equal numbers.

The Determination of Sex in Offspring.—Since man began to think he has been possessed with an anxiety to be able to control the sex of his own offspring and that of his cattle. Numerous alleged recipes for such control are current today among stockmen and farmers. There are two kinds of spermatozoa produced by the males of all species and

the two kinds are produced in exactly equal numbers, as indicated above. Whether the progeny will be male or female depends upon which kind of spermatozoan happens to fertilize the ovum. The two

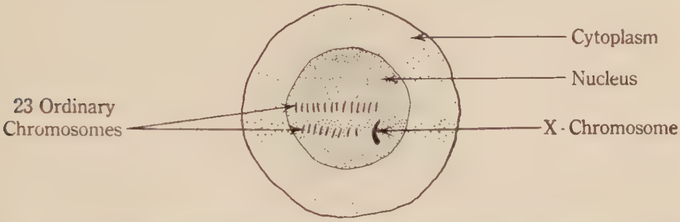


FIG. 47.—Diagrammatic drawing to illustrate the chromosomal conditions in the human ovum (egg).

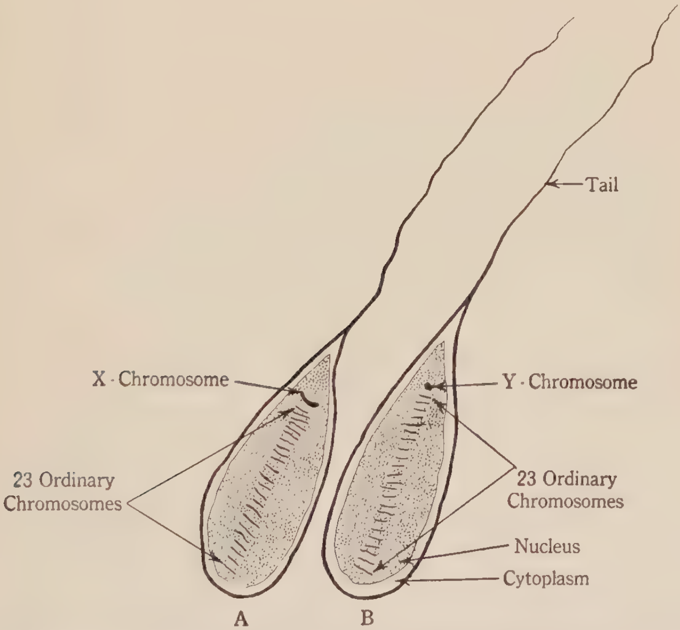


FIG. 48.—Diagrammatic drawing to illustrate the two kinds of human spermatozoa with regard to chromosmal contents.

kinds have equal chance of fertilizing. Hence, whether the progeny is to be male or female becomes pure chance. There is no method by which the sex of offspring may be controlled.

It will be recalled that the body-cells of the female contain 46 ordinary chromosomes and 2 X-chromosomes. It will be recalled also that in the ovum are 23 ordinary chromosomes and 1 X-chromosome. If the ovum becomes fertilized by the kind of sperm which contains 23 ordinary chromosomes and 1 X-chromosome, then in the resulting fertilized ovum will be 46 ordinary chromosomes and 2 X-chromosomes. This is the chromosomal condition in the female body-cells and the progeny thus will be female.

But if the ovum becomes fertilized with a sperm containing 23 ordinary chromosomes and the Y-chromosome, then the fertilized egg and the progeny will possess 46 ordinary chromosomes, 1 X-chromosome, and the Y-chromosome. This is the chromosomal condition in the body-cells of the male, and thus the progeny will be male.

Thus maleness or femaleness is determined by the kind of spermatozoan which succeeds in fertilizing the ovum. The 2 X-chromosome combination in the fertilized egg produces femaleness; the X-Y combination produces maleness. Or rather it is believed that the Y-chromosome has nothing to do with the determination of sex. It is thought that 2 X-chromosomes produce femaleness and that only 1 X-chromosome produces maleness.

A *reduction* in number of chromosomes contained in the body-cells occurs in the formation of the ova and the sperms, there being only one-half as many chromosomes in the germ-cells as in the body-cells. But the regular number of 48 chromosomes in the body-cells is restored in fertilization.

Since the formulation of the theory of sex determination in 1905 some modifications of the theory have been necessitated by further discoveries, but the essential facts as given above are accepted by most biologists. There is a small minority of biologists, however, who do not accept the chromosome theory of sex determination.

Chromosomes as Bearers of Hereditary Characters.—The sex chromosomes in the germ cells are probably the bearers of hereditary substances, or characters, which determine sex in the offspring, as related above. The hereditary substances which determine sex, or any other character of the offspring, are called **determiners.** The ordinary or body chromosomes in the germ-cells are the bearers of heredity substances or determiners from parent to child which determine the hair color, curly or straight hair, eye color, etc., in the offspring. The chromosomes are the vehicles for transmitting physical and mental characters from parent to child. Each chromosome may be conceived

as bearing thousands of characters inherited from innumerable ancestors. Some of the characters borne by the chromosomes will become conspicuous in the features of the offspring and their combinations produce the mental or physical characteristics of the progeny. Other characters will remain hidden or **recessive** and not observable. But the recessive characters may later be transmitted to individuals of a succeeding generation in which they become prominent and observable. Thus, each individual is an inconceivable complexity, composed of thousands upon thousands of inherited characters, visible and invisible, from unnumbered generations of the past.

Regarding the age-old controversy as to whether heredity or environment is the stronger influence in the life of the individual, animal or human, it may be remarked that most biologists regard heredity as the stronger of the two determining factors. Most biologists regard the possibilities of an individual as being definitely determined and settled at fertilization by the characters inherited through the chromosomes.

Mendel's Law of Heredity.—The remarkable Mendelian method of heredity was first discovered by Gregor Mendel, an Austrian monk who lived in the last half of the 19th century. He made the discovery by cross-breeding green peas or garden peas, the same as we in this country frequently term English peas. He read the results of his garden experiments to a group of neighbors, who probably dozed through the reading of his paper and little realized that one of the most amazing scientific discoveries of all the centuries was being presented. Mendel, not being a professional scientist but only an amateur experimenter, as he probably regarded himself, did not publish his findings in an outstanding scientific publication, but published it in an obscure journal in 1866. The discovery was lost; it never came before the eyes of men who appreciated its value. But Mendel's discovery was re-discovered in the year 1900, by the experiments of three biologists working independently in three different countries. This led to the discovery of Mendel's paper which had lain in dusty storerooms unnoticed.

Mendel's Experiments and Results.—Mendel worked with a dwarf or " bunch " variety of peas which grew to a height of only a few inches and with a tall or " running " variety which reached a height of several feet. He found that when the pollen of one variety was used to fertilize the flowers of the other, the resulting seed produced progeny (F_1 generation, meaning 1st filial generation) which were all tall. By crossing the progeny among themselves he found that one-fourth of the plants of the

second generation of progeny (F_2 generation) were **pure or homozygous** tall plants; that is, they were tall and did not possess dwarfness in their germ-cells, which was revealed by further breeding with each other. Also two-fourths of the F_2 generation were found to be tall, the same in appearance as the members of the one-fourth group; but by further breeding they were found to possess determiners for dwarfness in their germ-cells, for some of their progeny turned out to be dwarfs. The two-fourths group are termed **heterozygous** for tallness; that is, their own germ-cells are mixed, in containing determiners for both tallness and dwarfness. Finally, one-fourth of the members of the F_2 generation were found to be pure or **homozygous** dwarfs, their germ-cells being unmixed, alike.

It is now known fairly well, as believed by most biologists, how the determiners reside in the chromosomes of the germ-cells and how the determiners and chromosomes maneuver their positions to produce the one-fourth-two-fourths-one-fourth ratio. But the story of the maneuvers and changes of position is a very complex one which need not be related here.

Definitions.—It will be seen that the character tallness dominates in both the F_1 and F_2 generations of progeny. Tallness, then, is spoken of as the **dominant** of the two characters while dwarfness is mentioned as the **recessive** or hidden character. Two such contrasting characters as tallness and dwarfness are known as **allelomorphic** characters. There are many characters of plants or animals which are not allelomorphs. That is, many characters of plants and animals do not work out in the F_2 generation in the one-fourth-two-fourths-one-fourth ratio when those characters are crossed.

If starting an experiment with plants, or animals, to verify Mendel's Law, one must know in the beginning two things concerning the parental generation to be used: first, that the characters which he expects to observe are allelomorphs; second, that the parents are homozygous for those two contrasting characters.

Applying Mendel's Law to Animals.—As implied above, the Mendelian law applies to the lower animals and to the human being, in the same manner as it does to plants. For instance, if mice (Fig. 49) homozygous for gray color are crossed with mice homozygous for white, all members of the F_1 generation are gray, that being the dominant of the two allelomorphs. When the F_1 generation are bred among themselves the Mendelian ratio appears in the F_2 generation: one-fourth homozygous gray, two-fourths heterozygous gray, and one-fourth homo-

zygous white. What would be the results if the homozygous gray individuals of the F_2 generation were bred among themselves? What

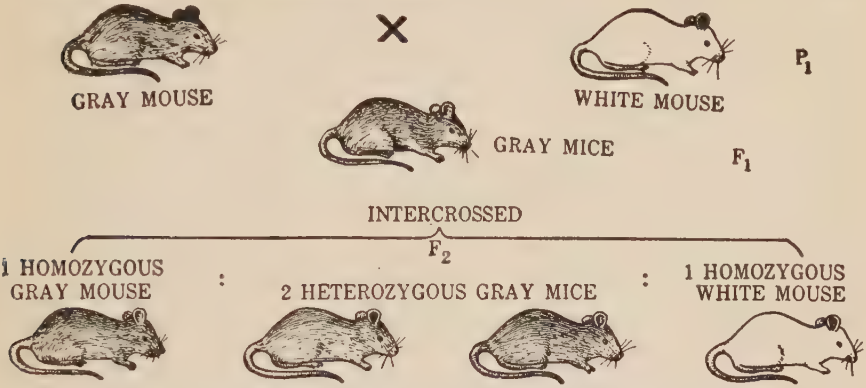


Fig. 49.—Results of mono-hybridization of mice which differ with respect to color of coat. Gray coat-color is *dominant* to white coat-color. (Modified from Curtis and Guthrie's "Textbook of General Zoology," published by John Wiley & Sons, Inc.)

results would follow the breeding of the homozygous white mice among themselves? Considering the fact that the heterozygous grays of the F_2 generation are similar to their parents of the F_1 generation, determine the results which would occur if the members of the F_2 generation were inter-bred.

Besides hair color, a number of allelomorphic characters among animals have been discovered.

Application of Mendel's Law to Man.—Some of the allelomorphic characters of the human are shown in the following table:

Dominant Character	Recessive Character
Brown eyes	Blue eyes
Curly hair	Straight hair
Dark hair	Either light or red hair
Normal pigmentation	Albinism
Nervous temperament	Phlegmatic temperament
Fused fingers or toes	Normal fingers or toes
Supernumerary digits	Normal number of digits
Fingers of only two joints	Normal numbers of joints
Legs dwarfed	Legs normal
Normal sized body	Midget
Normal mind	Feeble-mindedness

Sex-Linked Inheritance.—Some determiners are located in the sex-chromosomes and as a consequence the passage of such from parent to

child occurs in a very peculiar manner, known as **sex-linked** inheritance. Some persons show a tendency to bleed profusely on slight provocation, due to low capacity of the blood to coagulate. Such persons are known as "bleeders" or **hemophilics.** The condition is called **hemophilia.** Both hemophilia and color-blindness, recessive characters, are passed down

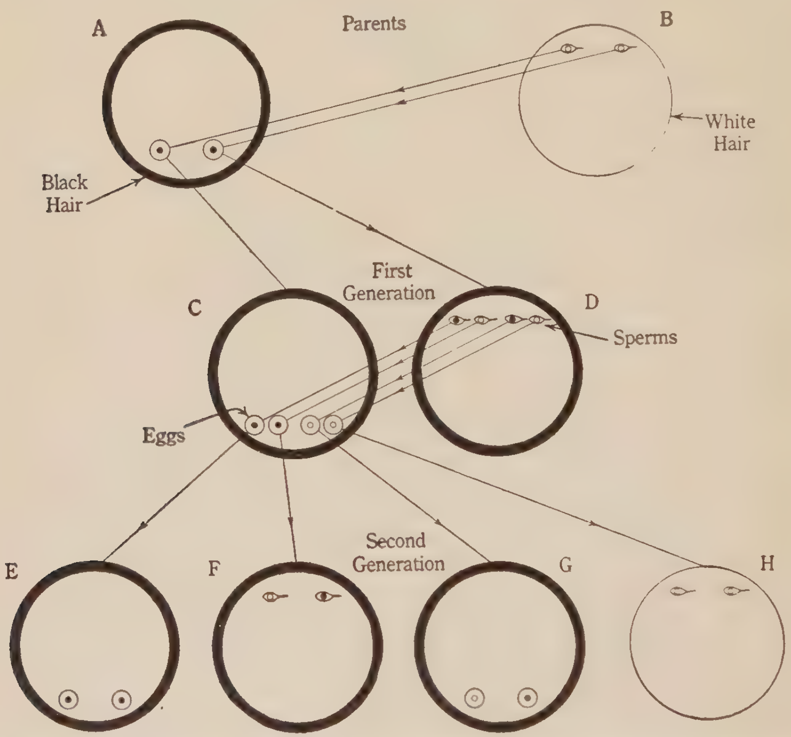


Fig. 50.—Diagram illustrating the mechanism by which the unit factor, color, is inherited in guinea pigs. Animal A is a black female of pure stock. Such an animal is called *homozygous* and all of its sex cells are alike in carrying the unit character in question. Animal B is a homozygous white male; none of the sex cells have the characteristic for blackness. Animal C (female) and D (male) are hybrids. In each case half of the cells carry the characteristic for blackness and half of them lack this characteristic. When C and D are crossed the offspring of the second generation are in the ratio of three black to one white. The diagram illustrates each possible chance-combination of sperm and egg and it will be seen that, of the second generation animals, E is homozygous, F and G are *heterozygous* like C and D, and H is a homozygous white. (From Turner's "Personal and Community Health," published by C. V. Mosby and Co., St. Louis.)

through the generations by sex-linked inheritance, that is, these characters are linked to the sex chromosomes. Supposing that a number of

male parents are color-blind but married to women of normal sight. None of the F_1 generation reveal the defect, but one-half the sons in the F_2 generation will be color-blind. But color-blindness in mothers descends in a very different manner. Color-blind mothers married to normal-sighted men impart color-blindness to all their sons, but it is not revealed in the daughters; to one-half of their granddaughters; and to one-half of their grandsons. It may be remarked that examination of school children has revealed eight times as many males to be color-blind as females. Color-blind persons are unable to distinguish red and green.

Twinning and Heredity.—How is that twins or plural births occasionally occur? This interesting question puzzled man for many generations. With reference to the method of origin of twins, there are two general types: **fraternal** twins and **duplicate** or **identical** twins.

Fraternal twins are those arising from different ova. Of course, the two ova are fertilized by different sperms and hence the sex of the two fetuses may be the same or may be different. Perhaps fraternal twins appear no more alike than do ordinary brothers or sisters. It is interesting here to note that girls born with twin brothers frequently are sterile, that is, frequently they never have progeny. The explanation is as follows: if the blood vessels of the umbilical cords of the two embryos fuse, as frequently happens, hormones from the testes of the male, which develop before the hormones of the female, are passed into the blood stream of the female fetus and produce the effect of sterility.

Duplicate twins (Fig. 53) arise from a single ovum, fertilized by a single sperm, which in its cell division developed outwardly from the early cell-mass in two directions, as we may say, thus resulting in the formation of two individuals. Such twins are of the same sex, necessarily. Explain why. Such twins are likely to resemble each other very closely. Why?

Which Parent Is Responsible for Twinning?—The question is sometimes asked: which is responsible for plural births, the male or female parent? In the case of fraternal twins it is reasonable that the responsibility can be laid at the door of the mother, her penalty for producing two ova instead of one as usual. The production of a plural number of ova, and fraternal twinning, shows a tendency to follow family lines, that is, fraternal twinning appears to reveal a tendency toward being hereditary.

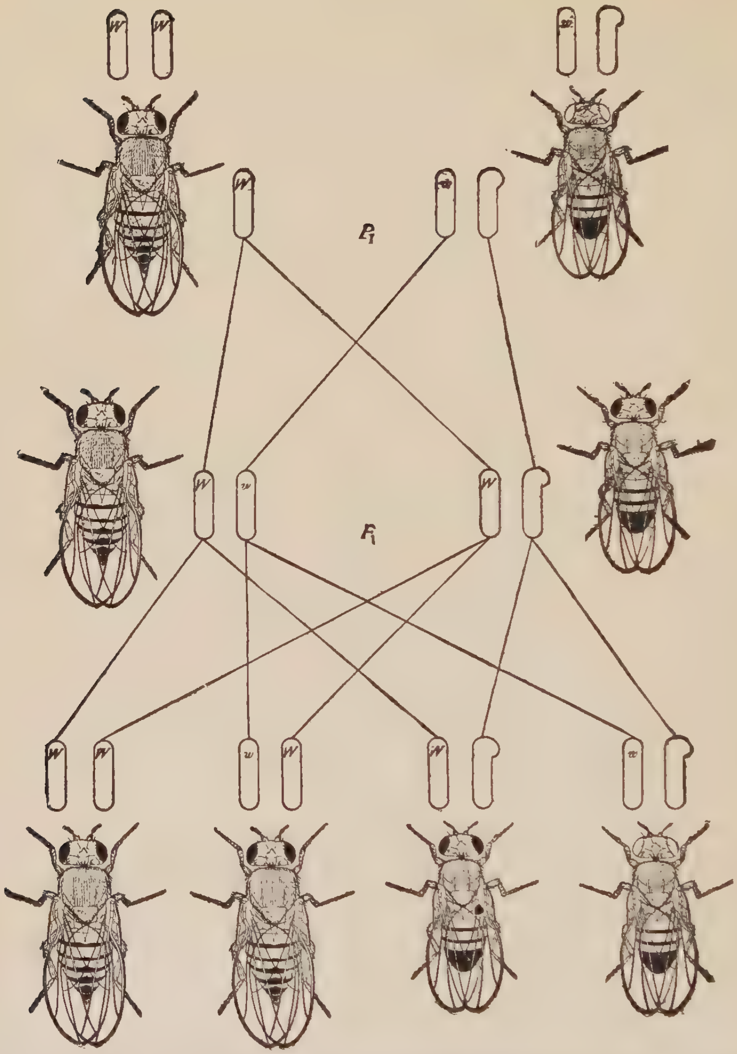


Fig. 51.—Results of crossing a red-eyed female *Drosophila* (fruit-fly) with a white-eyed male. The X-chromosomes are represented as carriers of the *genes* determining eye-color. *W* is the symbol used for a gene (determiner) for red eye-color, which is dominant to a gene for white eye-color, indicated by *w*. The hook-shaped chromosome which does not contain a symbol for a gene represents the Y-chromosome of the male. This cross is the reciprocal of that shown in Fig. 52. (From Morgan, *et al.*, "The Mechanism of Mendelian Heredity," copyright 1922, by Henry Holt & Co. Reprinted by permission. After Curtis and Guthrie's "Textbook of General Zoology," published by John Wiley & Sons, Inc.)

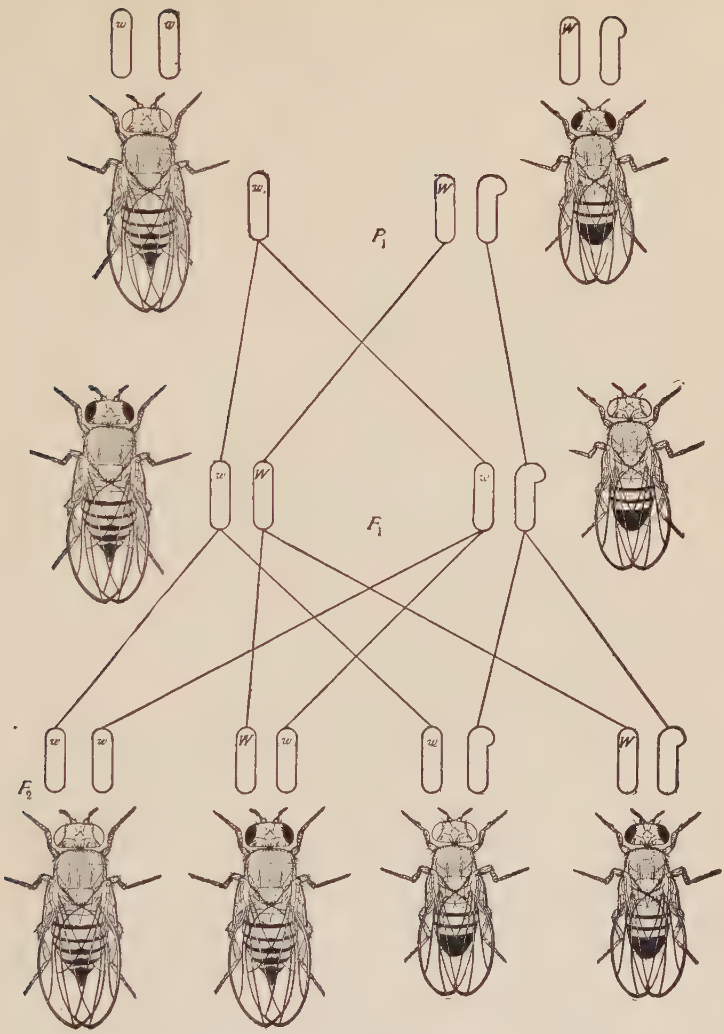


FIG. 52.—Results of crossing a white-eyed female *Drosophila* (fruit-fly) with a red-eyed male. Compare with Fig. 51. Both Figures 51 and 52 are examples of *sex-linked* heredity. In man, examples of sex-linked heredity are the tendency to being "bleeders" and color-blindness. (From Morgan, *et al.*, "The Mechanism of Mendelian Heredity," copyright, 1922, by Henry Holt & Co., and reprinted by permission. After Curtis & Guthrie's "Textbook of General Zoology," published by John Wiley & Sons, Inc.)

But in cases of duplicate twins it is impossible to place the responsibility, or credit as it may be, on the father or the mother. It is not known whether the ovum or the spermatozoan contains the substance which may determine the duplication. But mention might be made of the case reported by Dr. Berger of a German who married twice and had several plural births by each wife. By the first wife he had 1 set of quadruplets, and 10 sets of twins. The wife died. By a second wife were had 3 sets of triplets and 10 sets of twins. No record was made of the sex of these embryos nor any other information to indicate whether they were of fraternal or duplicate types.

FIG. 53.—One-egg human twin fetuses (identical or duplicate twins). The one on the left is headless and has a dead heart. It will be noted that the duplicate twins are attached to a single placenta. (After Schatz; taken from Newman's "Physiology of Twinning," published by University of Chicago Press.)

Double Monsters.—When fraternal twinning occurs, the embryos may be in such close proximity that they grow together or fuse to some degree. Or, in case of duplicate twins, the division of the embryonic mass may occur so late or so imperfectly as to produce two separate bodies only imperfectly. That is, the attempt to duplication may not be wholly successful and a two-headed, or a four-legged, fetus may be the outcome. Such are called **double-monsters** (Fig. 54) and occur with some frequency in the human being These monstrosities occur more frequently in cattle. If the separation of the fetuses is nearly complete they are termed Siamese twins.

Inheritance of Disease.—Infectious diseases are not inheritable in the proper sense, notwithstanding popular conceptions to the contrary. That is, no disease germ, nor disease determiner, is passed from parent to child through the ovum or spermatozoan. True inheritance takes place through the chromosomes of the germ-cells. The chromosomes of the spermatozoa and the ova do not transmit the germs of disease to progeny. And there are no such things as disease determiners in the chromosomes.

Although syphilis is not transmitted hereditarily, in the proper sense of the term, the injurious effects of the parent's syphilis upon his or her germ-cell may be continued in its effect upon the child. The child may be aborted; or, if born at term, it may be defective, physically or mentally or both.

Fig. 54.—A human "double monster." (After a photograph by Morrill; taken from Newman's "Physiology of Twinning," University of Chicago Press.) A considerable percentage of pregnancies are either single or double monstrosities, but nearly all are "miscarried" during the first few weeks.

However, one may inherit from a parent lack of capacity for producing certain anti-substances with which certain diseases may be opposed. In that case, he may be specially disposed toward a given infectious disease. One may inherit a low capacity for resisting tuberculosis, for instance. Or, again he may inherit a digestive tract weak in digestive powers, or a heart which is weak in functioning properly, or he may receive from the parent some other organ or system that is organically defective.

In the remarks above we were speak ing chiefly of germ diseases in their relation to heredity. There are some non-germ or non-infectious diseases for which tendencies may be inherited, hay-fever and asthma, for instance. And some few authorities now consider that there is a possibility that tendency to cancer may be inherited.

Congenital Transmission of Infectious Diseases.—A child may before birth acquire a communicable disease from the mother. This is known as **congenital** acquirement of a disease. Smallpox and syphilis, for instance, frequently are so acquired by the fetus, in just the same way that any member of the family may acquire those diseases when in intimate contact with the mother who may have them. Tuberculosis is sometimes acquired congenitally. However, if a child is infected from a tubercular mother, it usually occurs after birth, from the sputum or milk of the mother.

Heredity and Mental Disease.—Feeble-mindedness is inheritable by Mendel's Law. "Wooden legs are not inheritable, but wooden heads are." Feeble-mindedness is a recessive character. Strong mentality is also inheritable. During recent years the histories of a number of families showing particularly strong mentality or feeble-mindedness have

been worked out. Of these histories we may mention those of the Jukes and Edwards families as contrasts:

(1) *The Jukes Family.*—The mother of the Jukes family has come to be known as "Margaret, the mother of criminals." Margaret was married to a man of worthless type. The progeny of this couple number something like 1200 descendants. The number of these whose mental records have been traced are 709. Of the latter number 280 were found to have been supported by the State of New York. Criminals of the group numbered 140. The total number of years spent in prison by the criminals of this family was 140. The family cost the State of New York $1,308,000 in 75 years. The majority of the members of the family were of low physical, mental, and moral standard.

(2) *The Edwards Family.*—Elizabeth Tuttle, a young woman of high character and intellectual vigor, married Richard Edwards, a man of like character and intellect. They had a son, Jonathan Edwards, the eminent theologian, and some daughters. From this son and these daughters have been descended the following illustrious personages:

Jonathan Edwards, Jr., president of Union College
Timothy Dwight, president of Yale
S. E. Dwight, president of Hamilton College
T. D. Wolsey, president of Yale
Sarah Reeve, famed woman lawyer
Daniel Tyler, a general in the Civil War and founder of the iron industries in Alabama
T. W. Dwight, founder of the Columbia Law School
Timothy Dwight, the Second, president of Yale
Mrs. Eli Whitney, who aided her husband much in the invention of the cotton gin
M. E. Gates, president of Amherst College
Catharine Maria Sedgwick, author
C. S. Minot, famous biologist of Harvard University
Winston Churchill, novelist
Mrs. Theodore Roosevelt
Robert Paine
Chief Justice M. R. Waite, of the United States Supreme Court
General U. S. Grant
Grover Cleveland

(3) *The Kallikak Family.*—Martin Kallikak (the name is fictitious), a young soldier in the American Revolution, had an illegitimate son by a feeble-minded girl. This son had 480 descendants. Later Martin married a normal-minded girl. From his legitimate wife have been descended 496 persons. Thus the two lines of descendants have had the same father but different mothers, one of the latter feeble-minded and

the other normal-minded. The two lines contrast markedly. Note the following:

Illegitimate Line	Legitimate Line
Number of descendants, 480	Number of descendants, 496
Number sexually immoral, 33	
Number of confirmed drunkards, 24	
Number of epileptics, 3	
Number of feeble-minded, 143	Number of feeble-minded, none

Sex Hygiene.—Profitable measures in sex hygiene are the following: (1) Employment of the mind is the cardinal object in sex hygiene. Sex instinct is one of the most compelling forces of nature in the life of man. It is peculiar in that the more attention it receives, the more it demands and the more intensively are its demands made. The more sex is exercised, the greater the demand the tyrant makes. But for the successful man it must not encroach upon time and thought which should be given to the necessary everyday interests of life. To allow such encroachment is to forfeit success. To prevent devotion of time-consuming thought to matters sexual, it becomes imperative that one keep intensely busy with the affairs of life that interest him most. Leisure hours may with great profit be devoted to athletics or games. In no other phase of life is it so true that "an idle mind is the devil's workshop."

(2) Avoidance of little intimacies with the opposite sex.

(3) It has been claimed that a diet of excessively high protein content stimulates the sexual desire.

(4) A fairly hard cotton mattress is more desirable than a very soft bed which is heavily covered. The very coziness of a feather bed, for example, is itself suggestive.

(5) Immediately on waking in the morning it is good practice to go to the toilet, for a full bladder or a distended intestine exert pressure upon the internal sex organs and stimulate the sex impulse.

It is currently believed by many uninformed persons that men must exercise the sex impulse in order to enjoy the maximum health. Even Benjamin Franklin taught the error, discerning as he was in most affairs of life. But the medical profession stoutly denies that this is true. Abstinence and conformation to the conventions of society are detrimental to no man's health.

At least three good concrete reasons why the unmarried person should abstain from sexual relations can be offered: (1) His success in life, in business, and in marriage, is more probable if he adheres to the dictates of society. (2) The thoughtful person must consider his or her obligation to the other contracting party and to any new life which

they two may bring into existence. (3) The hazard of venereal diseases and the consequent serious effects which frequently occur should prove a strong deterrent.

Masturbation.—Masturbation is indulged in by both sexes. Even children may practice a form of masturbation. As to the percentage of young persons practicing it, authorities differ widely in their estimates. There are many erroneous notions current as to the effects of masturbation, such as the myth that it may lead to insanity. The chief detrimental effects of the practice are the destruction of self-respect and the strain upon the sexual organs occasioned by too frequent exercise of them which usually attends the habit.

Hygiene of Menstruation.—During the menstrual period the woman is below par with regard to physical, nervous, and mental stability. Those associated with her are obligated to treat her tenderly and to overlook any irritable tendency and physical shortcoming which she may display. She must be shielded from undue excitement or any unnecessary strong emotions, for these may stop the menses, which is detrimental to her well-being. Rapid loss of body heat, such as takes place when insufficiently clothed or on becoming damp and cold, also may stop the normal flow. However, there is no reason whatever why the woman during the monthly period should dispense with the accustomed bath. If the water and bathroom are warm there is no danger for her health. The woman may also take light daily exercise except in abnormal cases, which should be brought to the attention of the physician.

Hygiene of Pregnancy.—Upon becoming an expectant mother, the woman should visit a physician. The diet must be carefully supervised for calcium and vitamin content. Measurements of the pelvis must be made by the physician to determine if there be any deformity. In the pregnant condition the mother must not only supply herself and the embryo with nutriment, but she must also eliminate wastes of her own body and those of the fetus through her lungs and kidneys. The nutritional and excretory duties performed by her body prove a great strain for her. Frequent analyses of the urine must be made to guard against functional derangements. She must be relieved of heavy labor, which may produce an abortion of the fetus and thus endanger her life. Every expectant mother is due kindly sympathy and tender consideration. Any other attitude toward such a woman is humanly abnormal and intolerable. As to whether sex relations should be discontinued during pregnancy, the young married couple must make their decision in conference with their physician.

Myths Relating to Prenatal Influence upon the Fetus.—It has been indicated above that the fetus must be well nourished and it is further implied that the health of the mother is of great importance to the well-being of the unborn baby. But there are numerous myths relating to influence of certain mental impressions of the mother upon the physical character of the fetus. For instance, one myth is that the sight by the expectant mother of an unusual animal may produce such a strong impression upon her mind as to cause her child to be born with a hairy birthmark. Such old women's imaginings are, of course, without the slightest foundation. The notion that the mother can impart to her unborn child an unusual musical talent by listening to music is also a myth.

Eugenics.—The object of the endeavor to see that all individuals are well born is not to produce a race of super-men, as many of the misinformed suppose. But the object is the prevention by society, as far as possible, of the propagation of the physically and mentally defective. This is society's business, for society must support such mental and physical defectives as are born. Support of such persons costs Wisconsin $13,000,000 annually, and one-fourth of New York State's taxes go to institutions for the care of defectives. Institutions for criminals, many of whom are mentally defective, and for the feeble-minded and insane, cost the United States nearly 100 million dollars per year. Crime in Texas alone costs the taxpayers $260,000 every day. There are no figures available to show how rapidly the mental defectives are multiplying in the United States but investigations by the Royal Commission in England have revealed that the feeble-minded are increasing twice as fast in that country as the general population. The matter of preventing the propagation of undesirable stock thus becomes the concern of society at large and the business of the State.

It has been shown previously that insanity and mental deficiency are inheritable. Some states already provide by law that all persons proposing marriage shall have medical and mental examinations. Those who are mentally defective or who harbor venereal diseases are not permitted to marry. Some states furthermore provide that persons admitted to state institutions for the insane and feeble-minded shall be sterilized. Sterilization of the male is accomplished by cutting or tying off the vas deferens and the operation gives but little inconvenience to the patient. However, the sterilization of the female is a more serious operation.

The federal government now prevents immigration of those who show histories of certain diseases and whose family histories reveal mental defects.

CHAPTER XI

THE CARE OF CERTAIN ORGANS OF THE BODY

THE MOUTH, NOSE AND EAR

The Mouth an Ideal Habitat for Bacteria.—In Chapter I we mentioned the necessary conditions for prosperous growth of bacteria: moisture, warmth, oxygen (most bacteria require free oxygen), darkness, and food. The mouth provides all these requirements in an ideal manner. The food element is provided plentifully, if the teeth are not properly and regularly brushed. The mouth is capable of becoming the most unsightly, filthy, and disgusting part of the human body. At best, it is never clear of bacteria or of the undesirable effects produced in their putrefaction of lodged food.

The Brushing of Teeth.—The teeth should be brushed once a day as a minimum, after the evening meal. More frequent cleansing of the teeth and mouth is highly desirable. The brushing should be done systematically—first, the outside surfaces of the upper and lower teeth; second, the grinding surfaces; and last, the inside surfaces of both upper and lower rows. The brush should be manipulated in such a way as not only to brush *across* the surfaces of each tooth, but the bristles should also be drawn along the tooth from the gums toward the grinding surfaces so that bristles may remove particles of food from between the teeth. Many persons use tooth brushes which are too large to be used most effectively. Bristles should not be so stiff as to cause soreness or bleeding of the gums. If the bristles are too hard they may be softened by putting in warm water for a minute. Tooth pastes and powders are not necessary, though there are some that add to the pleasure of the brushing. Bacteria are removed more by the brushing than by any antiseptic property claimed for any powder or paste.

Decay of Teeth and Prevention.—The cause of the decay of teeth can not be definitely stated. But it is believed that decay is produced by acids formed by certain kinds of bacteria in the splitting of carbohydrate foods left in the mouth. If this belief is true, then the prevention of decay lies in frequent and careful brushing of the teeth. Without doubt, uncleanliness and tartar formation on the teeth are auxiliary agents of decay. So soon as a cavity first begins to make its appearance the decayed portion should be removed by a competent dentist and a

filling supplied to prevent further effect of the acid. Perhaps decay starts at a point where the hard outer layer, the enamel, has been cracked by accident or abuse. Such a fissure, although imperceptible, would serve as a point of entrance for the acid which is believed to dissolve the inner part of the tooth. Examination of the teeth should be had once or twice a year by a competent dentist.

But the prevention of weakness and decay of the teeth must be begun by the mother several months prior to the birth of the child. Some months before the child is born the teeth begin to form. At this stage it is of the utmost importance that the mother, by guarding her diet, furnish the unborn child with an abundance of lime or calcium for the construction of strong, solid teeth. The most abundant source of calcium is cow's milk, of which the prospective mother should consume large quantities, a quart or two per day. After the birth of the child it is also important that the mother's milk contain abundance of calcium. Therefore the mother must continue her large calcium intake. Furthermore, the child must continue to receive a plentiful supply of calcium, in milk, until his second set of teeth is attained, which is completed at about twelve years of age. Of course, the calcium content of the child's food is important for bone formation also. Recent experiments on animals indicates that Vitamin D is necessary in the diet of the mother both before and after birth of the young for the formation of strong teeth with thick enamel. If teeth are of normal hardness and of thick enamel they resist decay more effectively.

The Serious Nature of Decayed Teeth.—A cavity may extend into the central canal of a tooth, in which case the tissues contained therein are subject to infection with bacteria. In such a condition pus is formed constantly and absorbed into blood vessels just beyond the end of the root canal. This absorption may result in a general toxic condition of the body. Or such bacteria may erode their way through the walls of the blood vessels, enter the vessels and be carried to distant parts of the body where they may set up secondary abscesses. Such abscesses may appear even in the heart, which is one of the causes of "heart trouble." They may appear in the kidney or appendix. Or the bacteria in decayed teeth may lead to infection of distant joints, and consequent rheumatism. They may also lead to neuritis or inflammation of the nerves.

Strong and healthy teeth are necessary for efficient digestion, because quick and effective digestion is not attained unless the food particles are finely ground. Large particles of food are slowly digested because of the relatively small amount of surface accessible to the digestive juices. This retardation allows the innumerable bacteria of the intestine to split such foods. Some of the bacterial split products, of pro-

teins especially, may be harmful in the production of auto-intoxication, as mentioned previously.

Pyorrhea.—Pyorrhea is an inflammation of the inner lining membranes of the gums, the thin membrane which attaches the gums to the surface of the teeth. The cause of the inflammation was once thought to be due to a parasitic ameba. The amebic parasite is now known not be be the cause, though it is frequently present with the inflammation. The causal agents are pus-forming bacteria, but without doubt uncleanliness of mouth and collected tartar on the teeth are contributory factors.

In pyorrhea the attachment membrane of the gum is destroyed, as stated above. The gums become retracted toward the roots of the teeth, producing an ugly appearance. The teeth thus exposed down to near the roots are likely to be the site of aching pains, especially after partaking of cold water or beverages.

Much pus formation usually attends pyorrhea. By pressing the fingers upon gums affected with pyorrhea pus may be seen. Of course the pus is constantly exuded into the mouth and carried into the stomach, which may result in digestive disturbances. Some of the pus may be absorbed into the blood or may make its way into the blood vessels whose walls have been eroded by decay of the gum tissues. Such pus, containing bacteria and passing into the blood, may set up a generalized toxic condition of the body. Or there may be secondary infections started in distant parts. One who has a severe case of pyorrhea may be greatly reduced in weight and in health.

There is no definite cure of pyorrhea, except the removal of the teeth whose gums are involved. There are dental quacks, however, who advertise absolute cure. No reputable dentist will promise a cure, but he may be able to arrest or retard its further progress.

Regular and careful brushing of the teeth may perhaps prevent pyorrhea. After the diseased condition has once developed the brush will retard the progress. There are certain drugs also that may be used as mouth washes or that a competent dentist may administer and that will retard the development of pyorrhea, but not cure it. A good mouth wash to use in the home for retarding the progress of pyorrhea already developed may be made by putting 2 drops of fluid-extract of ipecac in a half glass of water.

The Tonsils.—The normal tonsil has deep fissures, or *crypts*, upon its surface and extending toward the center of the tonsil. Frequently bacteria become established in the narrow fissures and cause decay or inflammation of the tonsilar tissues. Pus is produced by such decay

and the pus " pockets " may be observable as white patches upon the tonsil. The bacteria (staphylococci, usually) so entrenched are difficult to destroy because of the relatively very deep and narrow crypts into which the germs make their way. Such foci of infection may progress to the extent of eroding the walls of the lymph spaces and blood vessels, thus allowing the bacteria to gain entrance to the blood stream. Such bacteria entering the blood stream may be carried by the latter to distant parts of the body where the germs may set up secondary foci of infection. They may set up infections in joints and lead to rheumatism of those joints. Of course, the pus from the primary foci in the tonsils is swallowed into the stomach and intestines, which may lead to detrimental results in the digestive tract. Also the pus and toxins from both the primary and secondary foci may be absorbed into the blood and thereby cause a generalized toxic condition. Such diseased tonsils are believed to admit disease-producing bacteria more readily into the tissues and blood. For instance, diphtheria bacilli on gaining entrance to the mouth and pharynx are more likely to establish themselves in a diseased tonsil than in a normal one. The bacilli in diphtheria carriers frequently are found on diseased tonsils. Often with the removal of such infected parts by surgical operation the diphtheria bacilli no longer can be found. Persons having the white inflamed patches upon the tonsils should seek the advice of a physician. Most of the bacteria causing formation of pus in the mouth and associated parts are staphylococci.

The tonsils may become enlarged to such a degree that they cause difficulty in swallowing and breathing. Persons with such enlarged tonsils or with infected tonsils may suffer frequently from tonsilitis. Such persons need the advice of a competent specialist.

Causes of Foul Breath.—The cause of foul breath is frequently a puzzle to persons who possess a desire to maintain a hygienic mouth. Among the causes of foul breath may be mentioned: (1) Abscesses of gums. The pus from such abscesses produces the foul odor. Abscesses of the gums or roots of teeth may not cause soreness and may be detectable only by means of the X-ray. (2) Infected tonsils. (3) Pyorrhea. (4) Decayed teeth. Of course the factor in the above-named conditions which causes the bad odor is the presence of pus. Also, food particles, especially of proteins, may find lodgment in the cavities of decayed teeth and may disseminate odors on being decomposed by bacteria present. (5) The decay of cast-off cells of the lining membranes of the mouth. The cells of the lining membranes die and scale off just as do the cells of the outer portion of

the skin. These cells are found most on the upper surface of the back end of the tongue. Therefore, it is of advantage to brush the back end of the tongue with a child's sized toothbrush. It is also of advantage to use a mouth wash made up of 2 tablespoonfuls of boric acid dissolved in a pint of warm water. The boric acid solution to some degree destroys the bacteria which cause the decomposition of the dead cells mentioned above. (6) Particles of food lodged between the teeth, especially meat. Such meat becomes decayed by action of bacteria, which accounts for the odor. Careful brushing is the remedy for this condition. (7) Foul odor of the breath may be due to improper functioning of the digestive tract. A constipated condition may lead to an abnormal amount of bacterial growth in the digestive tract which might produce foul odor in the breath. Many persons consider this the most prolific source of " bad breath," but this is not true.

Enlarged Adenoids.—Adenoids are tonsil-like masses of tissue located above the tonsils and in the posterior part of the nasal passage. Adenoids are a normal condition. It is only when the adenoids become enlarged that they attract attention. Enlarged adenoids affect the normal method of breathing, affect the facial expression as a result of mouth breathing, affect the hearing and the general intelligence as a result of impaired hearing. Adenoids that are enlarged close the posterior portions of the nasal passages, thus necessitating breathing through the mouth. Mouth breathing on the part of the child results in a narrowing of the upper jaw of the child and the protrusion of the upper front teeth beyond those of the lower jaw. Over-grown adenoids may also press upon the Eustachian tubes, which are passages from the naso-pharynx to the middle ear. Such pressure upon these tubes may be sufficient to cause their closure, in which case the mucus that normally flows down the tubes into the naso-pharynx no longer finds an exit. Furthermore, if the Eustachian tube is closed there results an unequal density and pressure of air on the two sides of the ear drum. The air within the ear drum is absorbed by the tissues and thus there is greater pressure upon the drum or membrane from the outside. This causes an inpushing of the ear drum and a resulting degrees of deafness. With the deafness there is a reduced amount of information reaching the child and a resulting failure to develop intellectually as rapidly as he might otherwise. As a result of the abnormal condition of the upper jaw and of the teeth mentioned above and of the reduced degree of hearing, the child assumes a blank, listless facial expression. Removal of the over-grown adenoids by surgery usually results in a surprising impulse in the growth of the hitherto apparent low grade of intelligence. The child which does not have enlarged

adenoids removed sufficiently early suffers a greatly reduced chance of success in life. Over-grown adenoids during the years of the early teens become reduced in size and remain so during the rest of life. But this reduction in size comes too late, after great damage has been done.

Other Obstructions of the Nasal Passage.—The septum or partition between the two nasal passages sometimes becomes bent aside, causing obstruction to breathing. Or occasionally the sides of the septum may become thickened to such a degree that breathing is hindered. Fleshy growths, known as **polyps,** may develop in the nose.

Sore Throat.—The usual cause of sore throat is an infection with any one of several kinds of bacteria, usually streptococci. For an ordinary sore throat, gargles made up of boric acid, two tablespoonfuls dissolved in a pint of warm water, or salt dissolved in water are fairly effective. Or the tonsils and throat may be swabbed with mercurochrome to advantage, provided one knows how to prepare a swab properly. Sore throats among children should be regarded with suspicion, for this is one of the symptoms of some of the more serious children's diseases, such as diphtheria, for instance. A persistent sore throat in a child should have the attention of a physician.

Catarrhal Membranes.—Catarrhal condition of the membranes means that the cells of the membranes are swollen and exude an excess of mucus. It causes more inconvenience than pain. It may be a hindrance to breathing or may reduce the sense of smell. There are several causes of catarrhal conditions of the membranes of the nose and throat. Among the causes of catarrh are the excessively dry air of improperly ventilated rooms in winter, dust, and other irritants. One who has catarrhal membranes is more subject to infections, to "colds" in particular.

Hare-Lip and Cleft Palate.—These defects are due to the failure of the bones during the embryo stage to develop properly. The defects may be easily remedied in early childhood by surgery. With the condition remedied, the child's opportunity for success in life is greatly enhanced.

Infections of the Middle Ear.—Bacterial infections may pass from the naso-pharynx through the Eustachian tube into the middle ear. The infections may cause earache or may cause a "running" of the ear. Earache occurring at rare intervals may be treated in the home by placing the ear on a hot water bottle. Even a hot brick beneath a pillow may suffice. Children subject to earache may wear nightcaps to advantage when they have colds. The dropping of warm oils into an aching

ear is regarded with disfavor by modern physicians. A very severe earache or a chronic case of earache should be taken to a competent ear specialist. Infections of the middle ear are dangerous. Frequently such infections extend into bone tissue (the mastoid) behind the ear with serious results, even death.

HOW TO CARE FOR THE EYE

Eye Defects and Their Corrections.—Among the commoner eye defects (Fig. 55) are: **short-sight (myopia)**, **long-sight (hypermetropia)**, and **astigmatism.** In the normal eye (**emmetropia**) parallel rays of light after entering the eye are converged in such a way that they meet on the retina. In the short-sighted eye the eyeball is too long from front to back, so that parallel rays of light entering and converging meet before reaching the retina. The short-sighted eye can not see distant objects distinctly. The defect may be corrected by use of concave spectacles. Parallel rays of light entering the long-sighted eye converge and meet, or would converge and meet, behind the retina, because the eyeball is too short from front to back. To correct this defect so that the person sees images of nearby objects convex spectacles must be had. Astigmatism is due to irregular curvature of the cornea or of the lens. Astigmatism may be corrected with glasses which are ground in such a way as to compensate for the irregular curvature.

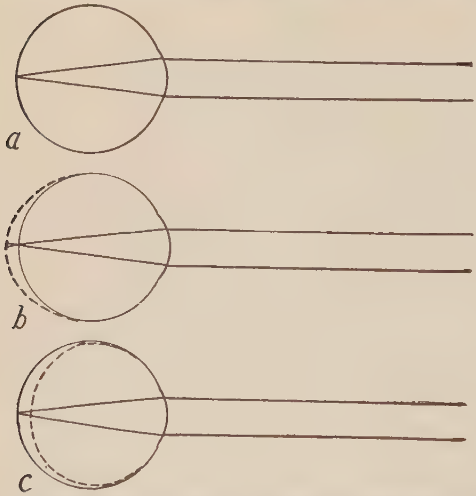


Fig. 55.—(*a*) Suggests the normal eye, focusing parallel rays, that is, rays of distant origin. (*b*) is a near-sighted eye, outline dotted; it is too deep to focus such rays but adapted to certain rays from near objects. (*c*) is a far-sighted eye, outline dotted, too shallow for any focus until the accommodation power is used. (From Stiles' "Human Physiology," W. B. Saunders Co.)

Crossed Eyes are due to defects in the length of the muscles, attached to the outside of the eyeball, that control its movement. This defect should be corrected in young children by an eye specialist.

A "**sty**" is an inflammation of tiny glands along the edge of the eyelids. The cause is not known definitely. Some believe that the inflammation is due to the straining of certain muscles of the eye in fine work such as reading, sewing, etc. Others believe it is occasioned by the entrance of germs into the small glands mentioned above, from dirty hands, for instance.

Twitching of the eyelids is an indication of eye-strain.

Trachoma has already been discussed in a previous chapter.

Many eye-waters and eye-drops offered for sale by druggists are frauds.

The Protection of the Eyes. (1) The eyes should be regularly examined by a competent oculist, particularly if headaches or twitching of the eyelids are experienced. Children should have examinations of the eyes made each year before entering school in the autumn. (2) The eyes should be frequently rested while reading or being engaged in other fine or close work. It is good practice to stop reading once in a few minutes and look away at distant objects, out the window, for instance. During the many ages in which man lived as a savage among the forests the eye came to be adapted for looking at distant objects, being rarely called upon to do fine, close work. When the normal eye is in a relaxed condition it sees distant objects. But when the eye is directed to objects within a few inches, as in reading, the ciliary muscles within the eyeballs must be strongly contracted to accommodate the eyes to the unnatural short distance. The ciliary muscles need be relaxed and rested once in a few minutes by looking away at distant objects for a short period of time. (3) A good light is necessary for reading, sewing, or similar fine work. Daylight, of course, is best. Of artificial light an electric lamp of blue glass is good. Perhaps it is best in most work that the light should pass over the shoulders. Why? For writing the right-handed person should have the light pass over the left shoulder so that no shadows fall upon the portion of the paper being written upon. The left-handed should have the light pass over the right shoulder. Buff or green colored walls and window shades are restful to the eye. Tinted glasses are advantageous for use in bright sunlight or while snow is upon the ground.

HOW TO CARE FOR THE SKIN

Bathing is not regarded as a necessity to health, although the warm bath, taken properly, promotes sleep and cold baths may reduce sus-

ceptibility to "colds." One of the chief objects of the bath to say the least is the esthetic.

Several methods or types of baths are employed, each adapted to a particular object. The **warm bath** at about the temperature of the body or a little lower, with a liberal supply of soap, is the type most used for cleansing. The alkali of the soap combines with the oil on the skin, making the oil soluble and diffusible in the water. But the warm bath when used for cleansing should be followed by a cold plunge, the latter to cause a reaction of the skin to be described below in connection with a discussion of the cold bath. The warm bath also may be used before retiring in the evening for the purpose of relieving fatigue and for soothing the nervous system as a preparation for sleep. Persons who suffer from insomnia may make profitable use of the warm bath. The warming of the skin causes the blood vessels therein to dilate, thus taking some of the blood supply from the brain, which is a condition necessary to the unconsciousness of sleep. The warm bath is not followed by a cold plunge when indulged before retiring to bed. No sort of bath should be had within two or three hours after a meal The diversion of a portion of the blood from the digestive system to the skin reduces the secretion of digestive juices necessary for digestion and thus delays the digestive process.

The **cold bath,** 60° to 70° F., is strongly stimulating, both physically and mentally. The dash of cold causes the circular smooth muscles in the walls of the arterioles to contract, thus driving most of the blood from the skin to the internal organs. The tiny muscles within the skin which control the pores also contract, causing the pores to close and in this way reduce the amount of perspiration and the amount of heat lost. When the body leaves the cold water the vessels of the skin dilate and the pores are allowed to reopen by the relaxation of the skin muscles. To increase the reaction of the skin the body may be rubbed vigorously with a towel of hard, rough texture immediately on leaving the water. The daily exercising of this heat-regulating mechanism promotes the efficiency of that mechanism in regulating the heat loss in sudden changes of temperature to which the body is subjected in winter. The efficiency and prompt action of the heat loss mechanism greatly reduces the chances of taking "cold." Therefore, the daily cold bath taken immediately on rising in the morning is one of the most important factors in promoting efficient operation of the heat-regulating mechanism and in preventing "colds." But aged persons should forbear taking cold baths, for it is too great a strain upon the hearts of such persons and the hardened arteries which

develop with increasing age. There is danger of causing rupture of the hard inelastic arterial walls of an aged person. There are even young persons who should not indulge cold baths. The shower-bath is more stimulating than the tub and is a cleaner method. An important invention for modern civilization is that of the bath-tub. Another advance in that line will be the elimination of the bath-tub and the establishment of the shower.

Nostrums and Quacks.—*Medicated soaps* are of no use. So-called *antiseptic soaps* are likewise useless. Experiments conducted by bacteriologists have shown that good qualities of soaps are sacrificed in attempts to make them antiseptic. The experiments showed that good plain soaps actually left fewer living bacteria upon the hands than did the soaps which claimed to be antiseptic.

Much has been written by " reformers " concerning the detrimental effects on the complexion and skin occasioned by the use of cosmetics. All such has been vast exaggeration.

Very much more harm may come from allowing barbers and beauty experts, so called, to squeeze blackheads or pimples. Such treatment bruises the tissues, causing them to swell more and allows infecting bacteria to enter the tissues and blood. Even syphilis may be transferred from the blood of one person to that of another by such workers, utterly ignorant of the most elementary facts of bacteriology and of the methods by which some of the deadliest diseases are transmitted.

The barbers and hair operators claim that they possess many magic remedies for dandruff. They likewise possess methods for magic transformations of hair. The barber singes hair with voluble assurance to the believing patron that his hair is soon to reveal remarkable evidences of rejuvenation. Not all such deluded patrons are classed generally with the ignorant. The author has known of a university professor who paid twelve dollars for an electric cap and who spent hours daily in his room with this wondrous hair restorer perched upon a bald pate while an electric current from a " plug " in the wall of the room passed into the cap on its mission of magic. Often even the supposedly highly educated betray dense ignorance and an utter lack of capacity to think in matters relating to the simplest elements of science or medicine.

The scalp and hair maintain a healthy luster when shampooed once a week. Massaging vigorously with the fingers, without scratching with nails, immediately on arising in the morning promotes the blood supply and health of the scalp.

" Chapped " skin is quickly relieved of all soreness by application of

vaseline, followed within a few minutes by rubbing excessive oil off with a towel, immediately before retiring for the night.

HOW TO PROMOTE HEALTHY MUSCLES AND CORRECT POSTURE

Physical exercise promotes health and efficiency of the human body in a variety of ways, among which several will be mentioned.

(1) **Exercise of the muscles increases the blood flow** within them. Accompanying the increased blood flow within the muscles the food and oxygen supplies are also increased. This leads to healthier and stronger muscles, capable of greater endurance. Also the muscles develop in size as a consequence; that is, the individual muscle fibers, or cells, increase in size, resulting in a total increase in circumference of the muscle mass. Exercise of the muscles, however, does not result in an increase in number of muscle fibers or cells.

(2) **Exercise increases the consumption of food,** especially dextrose, within the muscle, with a resulting increase in heat production. That is, more food is oxidized within the exercised muscle, which results in an increased amount of heat released. The increased quantity of heat may be advantageous to the body, particularly in winter.

(3) **Physical exercise trains the muscles in co-ordinating** with each other, thus producing greater dexterity, nimbleness, and grace of movement.

(4) **The effects on the skin** of physical exercise are of decided benefit to health. Exercise in the form of either work or play produces a dilation of the blood vessels within the skin. The resulting increased flow of blood to the skin warms the latter and the warmth causes the small muscles controlling the sweat pores to relax and allow the pores to open. There is an increased outpour of sweat. The evaporation of the sweat upon the surface of the skin tends to cool the body surface. The mechanism just described is one of the important factors in the regulation of the heat loss from the body. The exercise of the tiny muscles about the sweat pores accustoms them to making quick responses to the needs of the body with regard to heat loss or conservation. As the body passes out into the cold of winter the blood vessels of the well-exercised skin constrict, thus reducing the amount of blood appearing at the body surface and the amount of heat loss. Also when the body comes in contact with cold atmosphere the small muscles controlling the sweat pores contract and cause the latter to close, thus conserving the body heat. The heat-regulating mechanism of the well-exercised skin is much more likely to work efficiently in sudden changes

of temperature to which the body may be subjected and thus is more likely to aid in prevention of "colds."

(5) **Increased respiration results** from exercise of the body, which is necessary in order to supply oxygen for oxidation within the muscle cells and for the elimination of waste products of oxidation. The muscles used in respiration when duly exercised develop strength and endurance which may be of advantage in emergencies.

(6) **Exercise promotes the strength** and reliability of the muscles of the **heart,** which may be of great advantage in case of emergency in illness or surgical operation or in time when strenuous physical exercise becomes necessary.

(7) As a result of increased need of food on the part of the muscle when exercised the appetite is sharpened, **assimilation of food** accelerated, and the general state of nutrition promoted.

(8) **Likelihood of constipation is reduced** by physical exercise. Exercise of the skeletal or striated muscles directly or indirectly encourages motion of the smooth or unstriated muscles which make up a large part of the wall of the intestine. Exercise thus encourages **peristalsis,** slow wave-like constrictions of the intestines passing from the upper end of the intestines toward the lower end, carrying along the food and waste matter within the digestive tract.

(9) The exercise of the human body encourages the **formation of antisubstances** or immune substances which oppose the germs of certain diseases or the products of such organisms.

(10) **Effect of exercise upon the mind** is stimulating. The development of mind and of muscles accompany each other, and are interdependent to a great degree. One authority thinks that if a young child were bound so as to restrain muscular movement the mental effect would be idiocy.

Desirable Types of Exercise.—In former years gymnastics and calisthenics were the vogue in physical training. But in more recent years the effort is to select more natural forms of exercises, such as games and other related forms of spontaneous exercise. Tennis is one of the most desirable forms of exercise, particularly in the South, where it may be an all-year game. Baseball and handball, of course, are among the better games. Basketball and football are perhaps too strenuous to receive the complete approval of medical men. The last two named may cause particular strains upon the heart, its valves, for instance. The same criticism might be made of long-distance track. No one should engage in football, basketball or track without first having a thorough examination of the heart. Golf is an excellent diver-

stion for those of middle life or past, or for those who for some good reason are unable to undertake more strenuous exercise.

As to how much exercise one should indulge daily it may be said that a fair rule to adopt is to exercise an amount requiring an expenditure of energy similar to that expended in one hour of fast walking. In selecting one's exercise consideration must be given to his age. Also, one should have an examination of the heart and other organs yearly by a competent physican. Failure to consult a physician regarding one's exercise has resulted in death to many persons, even young persons.

The object of physical exercise is physical efficiency, not to become the strong man pictured in a certain type of magazines, which are so eagerly devoured by extremists.

Posture.—Stooped shoulders are among the most common defects of posture. This defect results from weakening of the muscles on the posterior side, thus allowing those of the anterior to draw the shoulders forward. Shoulders which droop forward crowd and cramp the organs of the chest. The lungs, for instance, are not allowed sufficient room for full expansion, which may prove to be a predisposing factor in tuberculosis. Even the heart may suffer from stooped shoulders.

Another common defect of posture is that of spinal curvature. Many cases of lateral curvature of the spine are developed by school children who are compelled to write on desks which are so high as to cause an elevation of the arm with which writing is done. A fairly large percentage of children in school reveal lateral curvature of the spine when their bodies are stripped to the waist.

Development of correct posture must be accomplished while the person is young. After full growth of the muscles and skeleton have been attained correction of an imperfect posture is well-nigh impossible. In the development of good posture a cheerful, optimistic outlook on life exerts a powerful influence. The person of cheer and happiness walks with an erect carriage. Reading books of fine ideals is recommended as encouraging the development of an erect posture. An erect carriage contributes no small part to one's chance of success in social and business life.

Use of shoulder braces to correct an imperfect posture is of no advantage. But braces may be of decided disadvantage by further weakening the muscles whose weakness is already the cause of drooping shoulders.

Most defects of the feet may be avoided with sensible selection of shoes. Perhaps it is a good practice for development of strong and

well-formed feet that children in warmer climates, particularly, are allowed to go bare-footed much of the time up to the adolescent age.

HOW TO CARE FOR THE HEART AND ARTERIES

Within very recent years disease of the heart and arteries has become first among the causes of death in the United States. Of the persons now living, one in five will die of heart or arterial disease.

Causes of Diseases of the Heart.—(1) Natural **organic weakness** of the heart is one of the sources of cardiac mortality.

(2) The **strenuous life** to which we are subjected in modern civilization is without doubt one of the causes of the premature failure of the heart. Overwork and the anxiety and worry frequently associated with the task of making a living may produce a weakened heart or may accelerate the weakening of a heart already by nature not strong.

(3) During the past several years the medical profession has learned that many " heart failures " are due to **infections,** recent or remote. In such diseases as diphtheria, gonorrhea, syphilis, scarlet fever, measles, pneumonia, infected tonsils and teeth, the germs may enter the blood stream and become established in the heart, especially in the valves of the heart. Such infections in the thin, membranous valves may produce thickened scars on the latter. The scar tissue may continue to form slowly during a period of years, may come to prevent the complete closure of the valves during heart action and may thus result in a leakage of blood in reverse direction. The failure of the valves to function properly is one of the chief causes of " heart trouble."

(4) Use of **alcohol** or **tobacco** to excess may accentuate the weakness of a heart already debilitated or diseased.

Hardening of the Arteries.—Hardening of the arteries, called by medical men **arterio-sclerosis,** occurs normally with advancing age. The hardening, accompanied by the loss of elasticity, of the walls of the arteries is caused by the deposit of mineral matter in the tissues of the walls. By the time that the average person is sixty to seventy years of age this hardening process has proceeded to a great degree. On post-mortem, the arteries of an old person feel hard and resisting when pressed between the fingers. The grating mineral deposits in the walls may be felt. Although such arteries are harder, they are much weaker and more brittle than those of a young person. Due to loss of elasticity and the resulting increase in blood pressure, the arteries of the aged may rupture with death resulting in a few moments. This

is most likely to occur in the arteries of the brain, in which case it is known as **apoplexy.**

Causes of Premature Arterio-sclerosis.—Among the causes of premature hardening of the arteries and increased blood pressure may be mentioned: (1) Overwork and anxiety. (2) Syphilis is one of the prominent causes of premature arterio-sclerosis and high blood pressure. The fact is that medical men frequently suspect syphilis when a young or middle-aged person dies of apoplexy. (3) Excessive use of alcohol and tobacco may be factors in premature arterio-sclerosis. (4) It has been claimed that overeating and chronic constipation may be causal factors in the hardening of the arteries and resulting high blood pressure.

Hygienic Care of the Heart and Arteries.—Among the preventive measures which are of use in the protection of the heart and arteries we may mention: (1) The adoption of a leisurely life. (2) Avoidance of infectious diseases so far as possible, including " children's diseases " and even infections that are usually considered of minor importance. (3) Temperance in the use of tobacco and alcohol, as well as in other phases of daily life. (4) Yearly medical examination of the heart, preferably on one's birthday. (5) Adjustment of physical labor and exercise to one's age and to any weakness of heart which may be present.

THE CARE OF THE MIND

I. Mental Disease.—It is well known that there are three great sources or occasions of insanity and feeble-mindedness. These three sources account for the great majority of cases of mental diseases.

(1) One among the chief sources of disease of the mind is **syphilis.** Of males who enter our insane asylums or hospitals, 10 to 15 per cent are cases of pareses produced by syphilis, and 2 to 3 per cent of females entering are cases of syphilitic paresis. The prevention of syphilitic insanity depends upon the prevention of syphilis, and the prevention of syphilis is one of the most difficult problems which confronts the human race. It was demonstrated in the United States Army during the World War that infections with syphilis could be reduced about one-half by the use of prophylactic ointments applied to the parts exposed to infection, if applied within a certain period of time after exposure. But it is doubtful if society, with its present view of morals, is yet ready for this advanced method of preventive treatment. In fact, since the War some city health departments have attempted amid

storms of criticism to induce the general use of the prophylactic ointments at the time of possible exposure.

(2) **Alcoholism** is another of the three main causes of insanity. Immediately after the adoption of the national prohibition amendment the number of cases of alcoholic insanity entering our insane institutions dropped one-half. But since that time the number of alcoholic cases entering insane asylums has gradually increased until it has now recovered its former figures. At the present time about 8 or 9 per cent of those entering hospitals for the insane are alcoholic cases. Alcohol is the hand-maid of syphilis in the production of paresis. But alcoholic insanity is usually of short duration; the patient recovers in a comparatively short period of time.

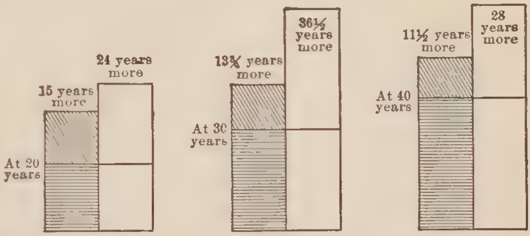


Fig. 56.—Alcohol and expectation of life. At every age the abstainers (white) have the chance of longer additional life than the moderate drinkers (shaded). (From Gruenberg's "Elementary Biology," Ginn & Co.)

(3) Perhaps **heredity** is the greatest single source of insanity and feeble-mindedness. Histories of families of feeble-minded parents have been traced through hundreds of descendants without the definite finding of a single case of normal mind. Prevention of hereditary insanity and feeble-mindedness would be possible to a very high degree, if society were developed to the point of accepting the measures. It is true that some states have legislated to prohibit hereditary mental disease but those laws are ineffectual because society has not yet become educated to the point of their acceptance, and enforcement. Preventive measures which may be mentioned are: (*a*) Education of the public to the importance of preventing hereditary diseases of the mind. (*b*) Legislation to prevent the marriage of persons capable of transmitting syphilis to mate or offspring. (*c*) Sterilization of the feeble-minded and insane on being released from institutions for mental diseases. The sterilization of the male is a simple surgical operation which causes the patient but little inconvenience, consisting of merely cutting or tying off the vas deferens. But in the female the operation is a more serious one, due to the inaccessibility of the Fallopian tubes which are cut or tied off to sterilize.

Eugenics is not an endeavor to produce a race of supermen, as fre-

quently supposed, but it aims at the prevention of the birth of unfit members of society. The aims of eugenics are for racial welfare. Eugenics is racial hygiene.

II. Mental Hygiene for the Normal Mind.—Little is known of the exact causes underlying mental disease. That is, not much is known as to what changes occur in the brain to produce mental disease. Therefore, not knowing the exact causes of mental disease we must know but little necessarily of how to prevent mental disease.

Value of Mental Hygiene to the Normal Mind.—Happy living requires the maintenance of a healthy mind. When we consider the question of the value of mental hygiene for the normal mind we recall Herbert Spencer's discussion of what constitutes the most valuable knowledge.

(1) Chief among the values to be received from the practice of mental hygiene is that of self-preservation. The mind must be depended upon to save the mind.

(2) Another value of the practice of mental hygiene is found in the rearing and disciplining of offspring.

(3) Still another advantage of training the mind in mental hygiene is the promotion of ability to adjust one's social relations. Happy and complete living requires adjustment to social environment. Friendships must be sought and adjustments must be made. Faults of associates must be overlooked. The keenly intelligent person, practicing mental hygiene, overlooks the faults of his neighbor and sympathizes with him while searching for an explanation of those defects, in the environment, rearing, or inheritance of that individual.

(4) Training oneself in hygiene of the mind prepares one for conducting miscellaneous activities of leisure. Intelligent persons cultivate love for things of nature in their environments—the luxuriously growing plants of summer, the severely rugged pictures which forests present in winter; the summer showers, the winter snowfall; animal life, the streams, the sky, the sunshine.

Personal Mental Hygiene Measures.—(1) *Care of the Body.*—The care of the body is fundamental in the care of the mind, for the health of the two are inseparable. The health of the two are interdependent. The mind must mind the body for the mind's sake. Those things essential to the health of the body must be attended—ventilation, proper dietary, wholesome physical exercise, avoidance of infections and toxins, avoidance of extreme fatigue, abundant sleep at a regular time, etc. Except in unusual cases, sleep may be easily induced under favorable conditions, some of which are: a fair degree of fatigue from the day's

work; warm feet on going to bed, which aids in reducing the blood content of the brain, a necessary prerequisite to sleep; exclusion of outside stimuli, such as light and noise; comfort in bed.

(2) *Self-Management.*—Acquirement of a power of self-management is another fundamental in the pursuit of the highest degree of mental health. Practice of adaptability under difficult situations is educative. Intelligent persons avoid anger. They cultivate ability to accept calmly without reply or comment a criticism or even an indignity. The most intelligent persons are merely interested in the lack of self-management exhibited by one who gives cause for feeling of insult. The intelligent person shows ability to manage self in the presence of desirable things which might easily be purchased but which are not necessities. Serene in fortitude is the mind of him who practices the economy of mental hyigene. It is a good method for one to set himself each day rigorously to the task of being for that day the kind of person which he hopes sometime in the future to be. Emotional balance is one of the most highly desirable accomplishments necessary for a thorough-going, well-rounded, successful life.

(3) *Introspection.*—Occasional self-examination and self-analysis is desirable. But many persons are so constituted that their main interests are within themselves. Such a person is chronically subjective. He is likely to run into mental difficulties, mental depressions, for instance. Those who are given overmuch to introspection must be diverted to the things of the outer world. They must be made to assume objective interests and objective ambitions. This class of persons must become out-minded to attain the greatest degree of mental health.

(4) *Solution of the Sex Problem for the Unmarried.*—Without doubt the sex problem of young unmarried persons has been exaggerated by the psychiatric thought of recent years. The sex problem of young people is not nearly so insurmountable as has at times been implied. Wholesome and frequent association with the opposite sex is to be desired. Diversion of thought from sex matters into other channels is easily accomplished by the very busy person. To maintain a deep interest in one's work or to engage in games or hunting and fishing carry one a long way toward settlement of the sex problem.

(5) *Mental Hygiene in Relation to Marriage.*—In the life of the adult, marriage may be one of the greatest sources of happiness or may be a source of a large portion of his difficulties. There may be two main sources of such difficulties: (*a*) sexual incompatibility, which leads to marital incompatibility and frequently to divorce. ~~The sexual incompatibility often is due either to ignorance of the husband or to~~

~~his inconsiderate nature.~~ (*b*) The economic problem also may prove an obstacle to happiness in married life, especially in such social and economic conditions as have prevailed in recent years. But this is not an insurmountable obstacle for the intelligent husband and wife who possess the capacity for correctly evaluating things of life. They will usually adjust themselves and their requirements to their economic situation. But those couples who are unable to select the real values out of life's offerings are likely to run upon obstacles which will precipitate them headlong into divorce courts.

ACCIDENT PREVENTION AND FIRST-AID

Accidents compose the most rapidly mounting cause of death in this country. Railroad and automobile accidents take a toll of life two to three times as great as in European countries. In the United States there are about 90,000 deaths annually from accidents, according to the records of the U. S. Census Bureau. And it is estimated that there are 2,000,000 serious injuries per year. The largest single items among accidents are the following, with their tolls:

Causes	Number of Deaths Annually
Automobiles	25,000 (1928)
Railroads	6,000
Drowning	6,000
Burns	6,000

Automobile accidents result largely from attempts of pedestrians to cross streets or roads at points where the motorist is not expecting them. Crossing streets only at street crossings would save several thousand lives and many thousands of injuries each year. A second practice which would prove productive in saving of limb and life would be the establishment of fixed habit of stopping at a street about to be crossed, looking all four directions, then proceeding only when no hurry must be made. Teachers in the schools would do well to take their classes out and drill them to establish this last mentioned habit. We give school children fire drills but we neglect drilling them in a practice the failure of which costs several times as many lives as do conflagrations. Children playing games in the streets is the third most prolific cause of deaths by automobiles.

Most **railroad accidents** occur to persons who are trespassing on railroad properties, and to motorists who fail to stop, look, and listen.

Many **drownings** would be saved if only all persons learned to swim while young and while it is so much enjoyed. And all young swimmers in their teens should practice methods of rescue in water and methods of resuscitation. The following are among the chief causes of drownings: (1) Getting out beyond the proper depth, in cases of those who can not swim. (2) Attempting to swim long distances or long periods of time. (3) Swimming within two hours after a meal. (4) Remaining in water after beginning to feel chilled. (5) Diving into shallow water or into hidden obstructions.

The great majority of accidents are preventable. Most occur because somebody did not consider.

Headache.—A headache is likely to be the result of constipation or of eye-strain. If either of these is the cause, the cause should be removed.

Treatment: Place feet in very hot water to above the ankles for 10 minutes. Go to bed and sleep. If one is subject to headaches and wishes to take aspirin for relief, he should consult his physician. Taking of aspirin is a hazard to some persons. It does not remove the *cause* of the pain.

If the cause of headache is constipation, the cause may be removed by dietary methods previously described. If eye-strain is the cause of headache, an oculist should be consulted.

Earache.—Apply hot water bottle. Do not put sweet oil or anything else into the ear. If earache is persistent or frequent, a doctor should be consulted.

Earache may be caused by enlarged adenoids which close the Eustachian tube and which results in unequal pressure on the two sides of ear-drum. Or earache may be due to infections of the middle ear which have passed up through the Eustachian tube from the throat, perhaps from a sore throat.

Toothache.—Go to a dentist at once. The cause may be more serious than suspected.

"Colds."—In the incipient stage a cold may possibly be stopped. Take vigorous exercise until sweating profusely. Then immediately take a hot bath, drink a hot lemonade, and get into a bed previously warmed. Stay in bed 24 hours or longer. Drink heavily of lemonade. Aspirin also may be taken.

"Heartburn."—This is due to a disturbance of the gastric juice of the stomach; it has no relation to the heart. It is caused by excess secretion of hydrochloric acid. It may be relieved by taking a half-

teaspoonful of baking soda in a glass of water. Tea, coffee, pepper, and spices should be avoided by one who is subject to "heartburn."

Frost-bite.—Rub the frozen parts first with snow or ice-cold water. Then gradually increase the temperature of the water. If warm water is used too soon mortification or death of the frozen part may occur.

Emetics.—It occasionally happens that for various reasons vomiting is needed to empty the stomach. A substance which causes vomiting is known as an *emetic*. Running of finger down the throat as far as possible and tickling the back side of the throat may produce vomiting. Drinking a large quantity of warm water may be sufficient to produce vomit. Or a teaspoonful of mustard or salt in a glass of warm water may be effective. Or again, two teaspoonfuls of syrup of ipecac makes a good emetic.

Poisons.—1. The **corrosive** or staining poisons are so-called because of the fact that they corrode the membranes of the mouth and digestive tract. An example is carbolic acid. If the poison is known to be an acid, give an alkali to neutralize the acid, such as baking soda in water, or soap. If the poison is an alkali give a weak acid such as vinegar, or lemon or orange juice. After neutralizing an acid or alkali, as suggested above, soothe the corroded part by giving an oil, such as olive oil, linseed oil, castor oil, or cooking oil. Also give strong coffee to stimulate. It is best not to give emetics if the poison is known to be a corrosive poison. Why?

2. The **irritant** poisons do not stain the mucous membranes as do the corrosive poisons. Examples of this group are bluestone (copper sulphate), paris green, arsenic (usually in rat poisons), bichloride of mercury (in antiseptic tablets). Treatment for irritant poisons: Give emetics. After vomiting give strong coffee, both to stimulate and to dilute any remaining poison. Give olive oil, linseed oil, castor oil, or cooking oil to soothe.

3. The **nerve** poisons do not stain the mucous membrances. There are two general types of nerve poisons: (1) the *sleep producers*, such as opium, paregoric, morphine, laudanum, soothing syrups, and head-ache remedies. Treatment: Give emetic; keep patient awake with strong coffee, walking and cold towels. Give artificial respiration, if it becomes necessary.

(2) The *convulsants* are such as strychnine, belladonna, and prussic acid. Strychnine is contained in some vermin killers. Treat ment for convulsants: Must be quick. Give emetic but do not wait for it to be prepared. While emetic is being prepared put finger in throat and tickle the back of the throat in effort to produce vomiting. If breathing stops use artificial respiration.

If the kind of poison is unknown, or if the antidote is unknown, give an emetic.

Snake-bite.—Quickly make a tourniquet between the wound and the heart (Fig. 67). Sterilize a knife blade in a flame if possible. Even a burning match may be sufficient to sterilize the point of the blade. With the knife cut through the wound to make it bleed rather profusely. Suck the wound. Carbolic acid or nitric acid may be put into the wound, if available.

Dog-bite.—If rabies or hydrophobia is suspected, make tourniquet on the side toward the heart from the injury and cut the wound with a sterilized knife. But do not suck the wound. Cauterize with carbolic acid or nitric acid. Do not kill the dog but confine and keep under observation for two weeks. If unfortunately the dog was killed, cut off its head and ship on ice to the state health department. It must be shipped on ice; it must be preserved.

First-aid Kit—A Red Cross kit or set of first-aid material may be had from drug stores. Such outfits should be in all homes, schools, and workshops. These packets contain such items as bandages; compresses; adhesive tape; rubbing alcohol for sprains, strains, bruises, and to refresh the skin during illness; aromatic spirits of ammonia, for faintness; boric acid, for eye-wash or gargle; carbolated vaseline in a tube, for treatment of burns; mineral oil, for laxative; syrup of ipecac, to cause vomiting; tincture of iodine or mercurochrome, for sterilizing wounds. These first-aid packets vary in size and contents and range in price from $1 to $15. Direction for use of the items contained accompany the packet or will be furnished by the druggist.

In Part IV will be found additional directions for first-aid; they are to be practiced in the laboratory.

HOW TO SELECT A PHYSICIAN OR DENTIST

All physicians belonging to the medical societies of their communities are reputable doctors. Physicians who are guilty of malpractice, or of immorality or of making impossible promises to prospective patients regarding their ability to cure incurable diseases, can not obtain admission to county medical societies, even though they have license to practice. All doctors who run large "ads" in the newspapers containing glowing promises and much self-recommendation are quacks. The same applies to advertising dentists. If in doubt concerning a given physician, one might telephone the president or secretary of the county medical society to learn if the doctor in question is a

member. If he is not a member, be assured there is a reason. There are also county dental societies to which all reputable and progressive dentists belong.

THE BIRTHDAY MEDICAL EXAMINATION

It is estimated by medical men that several years would be added to the average life in the United States if universal yearly medical examinations were had. In fact, it is believed this offers one of the most productive measures for extending the average life in this country. It would prolong the years of many persons who would find themselves on the verge of heart disease, diabetes, Bright's disease, cancer, etc. For such diseases do not develop in a day; they begin to develop and are detectable by the physician long before symptoms are noticeable to the subject himself. One should make it a constant practice to take a medical examination on his birthday. He should insist on a thorough examination, including, heart, lungs, kidneys and urine. Examination of the woman should include the uterus, especially in the case of women of middle age or older.

CHAPTER XII

IMMUNITY AND HOW TO INCREASE BODY RESISTANCE TO DISEASE

After a study of the various groups of infectious diseases, the balanced diet, etc., we are now prepared to appreciate immunity and methods of increasing the body's resistance to communicable diseases.

Definitions.—We have in preceding pages spoken of *communicable* diseases, studiously avoiding the term *contagious.* The latter term has come to be quite indefinite in its meaning. For instance, no one would question that smallpox is "contagious" in any accepted sense of that word, but if one proposed that typhoid is contagious a debate might be had, the validity of either side of the debated question depending on the accepted definition of the word. Therefore, because of this indefinite meaning, the term "contagious" has been dropped by public health men in recent years and the word "communicable" substituted. The literature of the American Public Health Association avoids the use of "contagious." The term "communicable" is a broader term, certainly more inclusive than "contagious" in the minds of some persons. Either smallpox or typhoid may be said to be communicable or infectious, without dispute.

There are two types of infection with regard to multiple infections which might be defined. To mention an example will be useful. Frequently it happens that during the progress of a case of typhoid the patient develops pneumonia also. There are thus two infections present. The typhoid is then referred to as the **primary infection** and pneumonia as the **secondary.** The typhoid does not "run into" pneumonia. They are two separate and distinct diseases present in the same body. Pneumococci and streptococci are conspicuous for their capacity for establishing themselves in the wake of other diseases, after the latter have reduced the resisting power of the body. The pneumococci and streptococci are thus opportunists, frequently present and lying in wait in the throat ready to seize their host when the latter's body has been reduced to low ebb in resisting power.

Toxemia is a condition in which the germs remain localized while their toxin diffuses throughout the blood stream and tissues. An example is diphtheria. It will be recalled that the diphtheria bacilli usually remain on the surface of the throat membranes, and that their toxin is absorbed into the tissues and blood.

Bacteremia consists of the invasion of the blood stream by the bacteria themselves. An example of this condition is typhoid fever. The term **septicemia** is used in much the same sense as bacteremia, although some authors differentiate between the meaning of the terms. **Pyemia** is a variety of bacteremia; it is the case of bacteria being spread through the blood stream from a primary focus to form secondary foci in distant parts of the body. An instance is the setting up of secondary foci in different parts of the body, the germs of the secondary foci coming from an abscess of a tooth or from an infected tonsil.

Immunity is the power or capacity of the body to resist and overcome a disease germ or its harmful products. Immunity is a relative term, for one may possess a high degree of immunity against a given disease or may possess a low degree. One's degree of immunity fluctuates. Again one individual or one species of animal may possess more immunity against a given disease than another individual or species. Thus one member of a family may be immune to influenza in an epidemic while another contracts it. The lower animals do not have typhoid fever, nor does man have hog cholera. Thus there may be *individual* immunity or *species* immunity.

Susceptibility is the converse of immunity.

Much confusion exists in the minds of most persons as to the differentiation of **vaccines** and **serums.** The student should fix this differentiation definitely in mind. A vaccine consists of injured, dead, or living virulent microorganisms, suspended in a fluid, usually in physiological salt water. Examples are the vaccines of typhoid, rabies, and smallpox, the virus of the last being suspended in glycerine. A serum consists of blood serum of man or of a lower animal in which are contained antisubstances or antibodies for a given disease. The antibodies have been previously developed in the body of the person or animal from whom the blood serum was taken. Examples of sera are diphtheria and scarlet fever antitoxins, and meningitis serum.

External Barriers of the Body.—(1) *The skin* constitutes a very effective barrier against microorganisms which would invade the body. Very few such organisms can effect an entrance through the unbroken skin. An example of organisms able to make their way into the uninjured skin are the staphylococci. The staphylococci live on the skin

as a normal habitat. Occasionally they pass down the hair follicles and there multiply to produce a **boil** or a **carbuncle.** A few parasitic molds also are capable of invading the intact skin.

(2) *The mucous membranes* of the nose, mouth, throat, stomach and intestine and of the respiratory tract also serve as a barrier against invading organisms. The gastric juice of the stomach contains a weak solution of hydrochloric acid which is germicidal to many kinds of microorganisms which find their way into the stomach, with food or drink and in other ways. But among disease-producing organisms which are not killed by the gastric juice are the typhoid and dysentery bacilli. The gastric juice also destroys some toxins, such as the diphtheria and tetanus toxins, but the botulinus toxin is not affected.

Peristalsis forces microorganisms down through the intestine and out with the intestinal waste. The typhoid bacillus is an example of an organism which is able to make its way through the intestinal membrane and set up diseased conditions. Occasionally *Bacillus coli* does the same.

Factors Predisposing the Body to Disease. (1) *Age of the individual.*—Diphtheria and measles are more likely to attack children than adults. Pneumonia takes a higher toll of the young and the old than of the middle-aged. Pulmonary tuberculosis and typhoid are more prevalent among young adults and the middle-aged.

(2) *Hunger and thirst* reduce the capacity of the body to resist disease. The body fed on a plentiful, balanced diet is more resistant. Accompanying war is usually a scarcity of food and as a consequence disease takes an increased toll. The respiratory diseases are likely to be the most prevalent under such conditions of reduced resistance.

(3) *Excessively high and low temperatures* also reduce the capacity to resist. The chick is always immune to anthrax (charbon) under ordinary conditions, but when placed in cold water readily succumbs to that disease. Frogs are also immune to anthrax ordinarily, but if placed in a temperature 10° C. above room temperature they contract the disease. The excessively dry and hot atmosphere of over-heated homes and the extreme cold of winter break down the body's usual resistance to "colds," influenza and pneumonia. This accounts for the fact that there is much more of these diseases prevalent in winter. It also accounts for the likelihood of pneumonia after chilling of the body from wet clothes. The excessive heat and cold reduce the body's capacity to manufacture the antisubstances or immune substances, some of which will be described in this chapter. Heat and cold also reduce the activity of those immune substances already present in the

body. Hygienic standards and methods of heating and ventilation have been discussed in connection with diseases disseminated by droplets. The rate of the body's heat loss is one of the most important factors of immunity.

(4) Furthermore, *excessive and prolonged fatigue* predisposes to disease. This can be demonstrated easily in the laboratory. The white rat is naturally immune to anthrax, even when injected with the bacilli hypodermically. But if the rat is made to run a treadmill until it is exhausted and then is injected with anthrax bacilli it succumbs. Soldiers on hard marches in which they get little rest or sleep become subjects to disease in greater numbers. If we would maintain a high degree of immunity we must rest and sleep plentifully at *regular* hours. The respiratory diseases are particularly apt to take advantage of any decreased capacity to resist.

The Invasive Ability of the Microbe.—Aside from the body conditions favorable to the invading organism, the parasitic bacterium possesses a greater or less degree of capacity for forcing its entrance and establishing itself in the body of the host. Its invasive ability may be great or small, depending on factors which will now be described.

(1) *Virulence of the organism* varies greatly even with different strains of the same species of bacterium. Only about one-tenth of the throats found to possess diphtheria bacilli possess the type which prove virulent or capable of causing disease. Some strains of the smallpox and influenza viruses are weak in producing disease while other strains are highly virulent and produce severe cases.

(2) *The number of the invading microorganisms* that gain entrance to the body is an important factor. The number may be so small as to be totally routed and destroyed by the antibodies of the host. In experimentation with guinea pigs it has been found that 10 to 150 tubercle bacilli must be injected hypodermically to produce tuberculosis in the pig. Fewer than 10 of the bacilli show no effect. Autopsies performed on human bodies frequently reveal a few tubercular scars in the lungs while the history of the individuals show that they never had suspected themselves as being tubercular. They had recovered from the tubercular infection, perhaps because the number of organisms which had gained entrance was too small to overpower their defensive substances. Probably it frequently happens that typhoid bacilli, for instance, gain admission to a human body but produce no symptoms of disease because they were in such small numbers as to be easily destroyed by the body defenses which at that time perhaps were in a high state for opposing the enemy.

(3) Still another important factor determining whether an invading parasitic microorganism shall possess high or low degree of invasive ability is *the route* or *channel* by which the bacterium gains entrance to the body. The tetanus or lockjaw bacillus may be eaten in great numbers with impunity, and doubtless are, since they are found in the human intestine. But if that bacillus is introduced into the tissues through a wound they multiply and tetanus promptly develops. The spirillum causing Asiatic cholera is much more virulent when swallowed than when introduced beneath the skin. In fact, the living virulent organisms of cholera are injected beneath the skin as a method of vaccination.

Types of Immunity.—There are two general types of immunity, **natural** and **acquired.**

1. *Natural immunity* is the immunity which the individuals of a strain, race, or species possess by nature when born. Natural immunity is not acquired during life. To a given parasitic organism one species may be immune while another is not. Most of the diseases of the warm-blooded animals are not known among the cold-blooded vertebrates. Or even strains of the same species may show marked differences in degree of immunity. Field-mice are very subject to glanders, a common disease of domestic animals of the farm, while house-mice are nearly immune. Jersey cows are more subject to tuberculosis than Holsteins; the Irish people are more subject than the Jewish people.

2. *Acquired immunity*, as its name implies, is immunity which is acquired during life. There are two sub-types: *active* acquired immunity and *passive* acquired immunity.

(1) In *active acquired immunity* the body participates in the production of the substance or substances which establish immunity for the body. The body is active in the defense. Active immunity may be attained in each of several ways:

(*a*) By having the disease, typhoid, smallpox, or diphtheria, for example. But not all infections confer immunity, pneumonia being an instance.

(*b*) By introducing living, virulent organisms into the body. As stated previously, this is the method of immunizing against cholera and was the method of immunizing against smallpox before the time of Jenner.

(c) By the introduction of living bacteria of diminished or *attenuated* virulence. The parasitic organisms may be injured or attenuated in two ways of interest to us here. First, they may be attenuated by

passing through the body of an animal in which the parasite finds a rather unfavorable environment. An example is the smallpox vaccine, taken from the body of a calf after having been introduced into its body. Second, organisms may be attenuated by desiccation or drying. The rabies vaccine, it will be recalled, is made by drying the spinal cords of infected rabbits, the cords containing the virus which is not entirely killed.

(*d*) By injection of dead bacteria, active acquired immunity may be established for typhoid fever. The same method is used for cholera and plague.

(*e*) By the injection of bacterial products. Examples are the active immunization against scarlet fever by introduction of toxin of *Streptococcus scarletinae*; and the active immunization against diphtheria with toxin-antitoxin, the toxin portion stimulating the tissues to produce antitoxin.

(2) In *passive acquired immunity* the tissues of the body take no active part in establishing it; the body remains passive. Until the advent of diphtheria toxin-antitoxin a few years ago, it was frequent that antitoxin was used for immunizing, as well as for cure. The antitoxin, of course, is horse serum containing the antitoxin proper, which neutralizes diphtheria toxin when in contact with it. The antitoxin is developed in the horse's body and transferred to the human body. In the immunization process occurring, the body tissues take no part. They remain inactive. Within some three weeks the antitoxin introduced has disappeared and immunity no longer exists.

Active acquired immunity is always much longer in duration than passive because the body cells continue for two or three years, or longer, the production of antibodies.

What Accounts for the Immunity of a Body?—1. *Phagocytosis. Phagocytes* are certain kinds of the white blood corpuscles that engulf or ingest bacteria which gain entrance to the body, in much the same manner as an ameba ingests particles of food. The process of ingesting bacteria by phagocytes is termed *phagocytosis*. There are also certain cells of the body which are "fixed" phagocytes, that is, they do not wander about through the body as do the white corpuscles but remain attached. Such fixed phagocytes are found in the liver, for instance. (The term, *phagocyte*, translated liberally means "eaters of cells.") Thus, the phagocytes aid in accounting for immunity.

2. *Antibodies* (also called *immune bodies* and *immune substances*). These are chemical substances which are found in the blood and fluids of the tissues. Some of them at least are present to some slight degree

naturally. But they are greatly increased in quantity by having certain diseases. There are several kinds of immune bodies, described as follows:

(1) *Opsonins* are chemical substances which are in the blood and which render invading bacteria positively chemotactic for phagocytes. They thus make the bacteria more easily phagocyted. Phagocytes ingest many more bacteria when opsonins are present than when there are none. Opsonins aid the phagocytes in performing their part of immunity.

(2) *Agglutinins* also are chemical substances in the blood of persons who are immune to certain diseases, to typhoid, for example. Agglutinins cause invading bacteria to *agglutinate* or clump together in close bunches of a hundred to two hundred in a clump. The bacteria remain motionless, although they are not killed. The agglutination of the bacteria is an aid to certain kinds of the phagocytes in ingesting the bacteria.

The agglutinins are of practical value in the laboratory to diagnose typhoid fever. If a patient is suspected of having typhoid, a few cubic centimeters of his blood may be drawn and the serum separated. Then some of the serum is put into a test-tube and known typhoid bacilli are added. If the bacteria are clumped together, in big masses, which may be seen in the serum with the unaided eye or with low magnification, then it is known that typhoid agglutinins are present in the patient's serum and that he has typhoid. This laboratory test with the serum of a suspected typhoid patient and known typhoid bacilli is called the *Widal* test, so named from the bacteriologist who devised the test.

(3) *Precipitins* are believed to be identical with agglutinins. For this reason and because they are rather difficult to describe intelligibly nothing more than mention of them will be made here. Precipitins appear in the blood of persons who have typhoid, just as do agglutinins. How precipitins function to aid in immunity is not at present known.

(4) *Antitoxins* are also chemical substances in the blood of persons who are immune to certain diseases, of persons who have had diphtheria, for instance. The presence of an antitoxin in the blood which may neutralize its corresponding toxin that chances to enter the body also partially accounts for immunity.

(5) *Lysins.*—The word *lysin* means "to dissolve." Lysins are chemical substances in the bodies of animals and man that dissolve the bodies of invading bacteria. Lysins ordinarily are in very slight quantities in the blood. Lysins are utilized in the *Wassermann* blood test to determine if the possessor of the blood is syphilitic.

Perhaps there are other substances in the body that are now unknown and that aid also in making the body immune. It is definitely known that all of the above, possibly excepting precipitins, aid in establishing immunity.

SUMMARY OF HOW THE BODY'S RESISTANCE MAY BE INCREASED

Summarizing, we may say that the body's capacity to resist disease may be increased in the following ways: (1) Taking precaution to maintain an intact skin, and in case of a broken skin sterilizing at once with either tincture of iodine or merchrochrome, preferably the latter. (2) Maintaining a high degree of body efficiency to produce antibodies against disease by the avoidance, so far as possible, of extreme hunger and thirst; high and low temperatures; excessive fatigue which comes with overwork, loss of sleep, and lack of a properly balanced diet; and avoidance of all chance to get mass infections, or even small infections, through water and food and by the respiratory tract. (3) Being immunized with certain vaccines and sera, especially those of smallpox, typhoid, diphtheria and scarlet fever for children, and with those of the first two named for adults.

PART III

ADDITIONAL TOPICS RELATING TO COMMUNITY HEALTH

CHAPTER XIII

THE IMPORTANCE OF SAFE MILK AND METHODS OF PRODUCING IT

Value of Milk as a Food.—Milk is the most complete food we possess. That is, it most nearly approaches being a perfectly balanced ration. But for persons past the ages of one or two years milk alone is not a perfect food. One serious objection to its being made the exclusive article of diet would be the fact that an active person would have to consume too large quantities to obtain sufficient food. Dried, condensed, and evaporated milks are good food. However, the vitamin content of such milks is greatly reduced or entirely destroyed. These milks should not be fed to babies except under advice of a physician.

Composition of Milk.—Cow's milk, on the average, contains the organic foods in approximate proportions by weight indicated in the table below. For the sake of comparison, the approximate proportions of constituents in human milk are also shown.

	Cow's Milk, Per Cent	Human Milk, Per Cent
Sugar	5	7
Fat	4	4
Protein	3	1.5

The fat or cream of milk is ordinarily rich in Vitamin A and Vitamin B. Moderate amounts of Vitamin C are usually present, except in late winter, perhaps, and small amounts of Vitamin D.

Another constituent of utmost importance, especially to growing children, is calcium. This mineral is necessary to form teeth and bone tissue.

Cow's milk may be modified for infants with the addition of boiled water and sugar in certain proportions dependent on age of the baby. This must be done under the direction of a physician. Diluting with

water is to reduce the concentration of the protein content so that it will be in about the same proportion as in mother's milk. After the dilution is made, sugar is added to bring the sugar content up to the proportion found in human milk.

Difficulty of Preventing Contamination.—Unfortunately milk is the most easily contaminated with bacteria of all the foods, due chiefly to its being a fluid and an excellent food for microorganisms. Being so excellent a food for bacteria and so easily contaminated with them it is the most decomposable of the foods. The drawing of the milk from the cow, the handling of it, the transportation of it, all offer innumerable opportunities for introduction of microorganisms. Because it is a liquid, the bacteria are soon thoroughly distributed throughout the bulk and multiply with almost unbelievable rapidity if the milk is of proper temperature.

The non-pathogenic bacteria may produce two types of chemical changes in the milk. Certain kinds of microorganisms, chiefly *Streptococcus lactis*, may split the lactose or milk sugar to form lactic acid, thus causing the milk to sour. Other bacteria, which multiply more slowly, may split the proteins to produce *putrefaction*, after the development of acidity. Putrefaction produces foul odors and renders the milk useless.

Sources of Contamination.—The sources of bacteria introduced into the milk include the udder of the cow. On the average, about 500 to 700 bacteria per cubic centimeter of milk, come from within the udder itself. If the cow is in an advanced stage of tuberculosis, the tubercle bacilli pass through in the milk. Dust falling from the flanks of the cow into the milking pail carries microorganisms into the milk. Water used in rinsing the utensils may serve as a vehicle for introduction of bacteria. But the most dangerous source of microorganisms which get into milk is the hands and droplets from the nose and mouth of the dairy worker. Man, himself, is the greatest source of danger.

Importance of Care in Handling and of Temperature.—It has been indicated above that the manner of handling and the temperature at which milk is kept are of great importance in maintaining a low bacterial count in milk.

Reducing a little the initial contamination of milk results in a vast reduction of the number of bacteria which may be present when the milk is 24 hours old. The more careless and the dirtier the methods of handling milk the greater will be the contamination with bacteria. Low temperature prevents rapid multiplication of the bacteria introduced into the milk.

The table given below shows the effects on bacterial content of care in handling and of temperature maintained.

	Age of Milk	Kept in Ice Box	Kept at Room Temperature
Milk handled with great care....	24 hours	2,500 bacteria per cc. of milk	450,000 per cc.
Milk handled with ordinary care..	24 hours	38,000 per cc.	4,000,000 per cc.

In the smaller towns, especially, where the dairies may not be carefully supervised by the city health departments, there are likely to be great differences in the number of bacteria per cubic centimeter (a cubic centimeter is about $\frac{1}{16}$ of a cubic inch) of milk from different dairies. In such small cities and towns there may be some well-equipped and well-managed dairies, but there are likely to be some very poorly managed ones. The table below shows the bacterial count of the milk of certain dairies selected from the published monthly report of the health department of a city of 50,000 population. Note the great differences in the number of bacteria found by laboratory examinations made of the milk taken from the delivery trucks of these dairies.

Name of Dairyman	Percentage of Fat	Number of Bacteria per Cubic Centimeter
A. L. Whipple......................	4.2	7,000
Baylor University Dairy.............	4.3	38,000
A. S. Bowles......................	4.6	200,000
J. H. Youngblood..................	5.0	465,000
H. H. Cox.........................	3.8	1,120,000
Guy McNamara......................	5.2	5,000,000

Milk as a Vehicle for Dissemination of Diseases.—There is only one common disease of cows in this country which is conveyed to man by milk. That is bovine tuberculosis. Cows in the later stages of tuberculosis show the tubercle bacilli in their milk. By means of the tuberculin skin test of dairy cattle, it was found that 2 to 8 per cent of cows were tubercular. In 1927 it was reported that of 258 samples of

milk bound for Chicago and examined bacteriologically, 3.5 per cent contained tubercle bacilli. In general, tuberculosis is more prevalent among cattle of northern latitudes where they are housed most of the time during the long winters. Jersey cattle are more subject to tuberculosis than most other breeds.

Human tuberculosis may be transmitted from a tubercular dairy worker who infects the milk. Other diseases conveyed by milk from diseased workers or carriers are diphtheria, scarlet fever, dysentery, streptococcic (septic) sore throat, " summer complaints " or diarrheas of babies, and typhoid fever. Typhoid and dysentery may come from contaminated rinsing water used for milk utensils, as well as from patients or carriers directly. Contaminated milk is one of the most prolific sources of typhoid. For instance, about 50 per cent of the cases of typhoid occurring in Massachusetts in 1924–26 were traced to milk. The " summer complaints " of infants fed on cow's milk are not caused by any particular kind or kinds of bacteria. Mass contamination of milk by even non-pathogenic bacteria may produce these intestinal disorders of babies.

In 1926 there occurred in the United States and Canada 69 outbreaks of diseases due to contamination of milk with the germs of these diseases by milk workers who were diseased or were "carriers." Several states and provinces did not report. The following table shows the distribution of those outbreaks among the various diseases, the number of cases, and the number of deaths occurring from those outbreaks.

Number of Milk-Borne Diseases in United States and Canada in 1926

Disease	Number of Epidemics	Number of Cases	Number of Deaths
Diphtheria	3	64	0
Scarlet fever	4	205	3
Septic sore throat	4	1038	9
Typhoid fever	54	1191	80
All other diseases	4	317	0
Total—all milk-borne diseases	69	2815	92

In 1927 at least 36 epidemics from contaminated milk are known to have occurred in the United States alone.

The State Health Department of Massachusetts has data which show that milk-borne epidemics in that state have constantly been on the decrease as the milk supplies have been more and more carefully supervised by health authorities during the last twenty years. The increasing amount of pasteurization in the cities has been a great factor in reducing milk-borne disease.

Pasteurization.—Pasteurization, as previously stated, is heating of milk at 140° F. to 145° F. for a period of 30 minutes. It is of great importance that the degree of heat and time named be adhered to in pasteurizing. Failure of a pasteurizing plant to carry out this regulation cost Montreal a typhoid epidemic of 5000 cases in the spring of 1927. Such heat destroys all pathogenic bacteria and most non-pathogenic bacteria, as experiments have shown many times. Most of the lactic-acid-producing bacteria also are destroyed and the milk thus keeps much longer without souring. The fact that milk is to be pasteurized, however, should not be allowed as an excuse for production of dirty milk. Dirty milk should not be tolerated under any condition whatsoever. The two advantages of pasteurized milk named above are attended by one disadvantage, however; namely, even the degree of heat used in pasteurization destroys a large part of Vitamin C present. This is not a serious matter for the adult person who consumes a reasonable variety of fresh foods for he obtains Vitamin C from those foods. But it is of concern for the young child whose diet consists wholly or largely of cow's milk. However, the loss of Vitamin C from pasteurized milk may be easily compensated for by giving to the child daily the juice of one orange or lemon or tomato, since these fruits are especially rich in Vitamin C. It is almost unanimously regarded as better and safer that the child receive pasteurized milk together with juice of one of the fruits named than to take the risk of diarrheas or other diseases from raw milk.

Recently the health authorities of Chicago have demonstrated that defectively constructed machinery in pasteurization plants may result in failure to pasteurize all milk. If the pasteurizing vats are so constructed that nooks or " pockets " are present in valves or pipes leading from the vats, then milk in such pockets may escape sufficient heat for pasteurization and disease germs may thus escape being killed.

Small home pasteurizing outfits may be purchased at hardware stores for less than five dollars (Fig. 57).

Pasteurization Reduces the Infant Death Rate.—A New York institution where sick babies were received and kept for treatment

Milk-Borne Outbreaks Reported by State and City Health Officers as Occurring in the United States in 1927

U. S. Public Health Service—Office of Milk Investigations

Date	Disease	Place	Number of Cases	Number of Deaths	Raw or Pasteurized Milk	Case or Carrier Found at Dairy
1927						
Mar.	Typhoid	Tempe–Mesa, Ariz.	15	4	Raw	Carrier
Mar.	Typhoid	Napa State Hospital, Cal.	29	5	Raw	Carrier
Mar.	Typhoid	Colorado Springs, Colo.	46	3	Raw	No
Apr.	Typhoid	Tampa, Fla.	3	1	....	Carrier
June	Typhoid	Cairo, Mounds, Ill.	15	1	Raw	Case
Sept.	Typhoid	Hegeler, Ill.	14	2	Raw	Carrier?
Aug.	Typhoid	Lafayette, Ind.	12	0	Raw	......
May	Typhoid	Michigan City, Ind.	3	1	Raw	......
Sept.	Typhoid	Fairfield, Iowa	10	1	....	......
Apr.	Typhoid	Hawarden, Iowa	43	3	....	Cases
Sept.	Typhoid	Hoisington, Kan.	46	1	Raw	Case
Sept.	Typhoid	Corbin, Ky	8	0	Raw	......
Oct.	Typhoid	Owl's Head, Me.	6	1	Raw	Carrier?
Aug.	Typhoid	Rumford, Me.	20	0	Raw	Carrier
Dec.	Typhoid	Van Buren, Me.	7	1	Raw	Case
Mar.	Typhoid	Billerica, Mass.	23	1	Raw	Carrier
Oct–Nov.	Typhoid	Int'l Falls C., Minn.	6	0	Raw	Carrier
July–Oct.	Typhoid	Moriah, N. Y.	25	4	Raw	Carrier
Dec.	Typhoid	Yellow Springs, Ohio	8	2	Raw	Carrier
Jan.	Typhoid	Bartlesville, Okla.	9	0	Raw	No
Oct.	Typhoid	Medford, Oregon	40	4	Raw	Case
June	Typhoid	E. Hempfield Twp., Pa.	10	0	Raw	Carrier
May	Typhoid	Mt. Pleasant, S. C.	23	0	Raw	No
July	Para. B.	Hohokus Boro *and* Saddle River Boro, N. J.	43	0	Raw	Cases
Mar.	Para. B.	Bridgewater, Va.	10	0	Raw	Carrier
May	S. Fev.	Washington Boro *and* Washington Twp., N. J.	199	0	Raw	......
Sept.	S. Fev.	Riverside Boro *and* Paramus Boro., N. J.	9	..	Raw	......
Nov.	S. Fev.	Schuylerville, N. Y.	29	0	Raw	Case
Aug.	S. Fev.	Kalispell, Mont.	139	3	Raw	Carrier
Jan.	S. Fev.	Janesville, Wis.	22	2	Raw	Case
Nov.	Diphth.	Pella, Iowa	9	0	....	Carrier
Oct.	Diphth.	Anderson, S. C.	6	0	Raw	Carrier
Sept.	Malta F.	South Bend, Ind.	1	0	Raw	......
Feb.	Gastro-Enteritis	Watertown, S. D.	50	0	Raw	......
Dec.	Malta F.	Hindman, Ky.	11	1	Raw	......
Sept.–Oct.	Malta F.	Newark, N. Y.	3	0	Raw	......
Totals	36		952	41		

showed a great difference in the infant death rate before and after pasteurization of milk was instituted. Note the following table:

EFFECT OF PASTEURIZATION OF MILK ON INFANT DEATH RATE IN A NEW YORK INSTITUTION

	Number Treated	Number of Deaths	Percentage of Deaths
For 3 years before pasteurization was begun	3609	1509	42
For 3 years after pasteurization was begun	3465	824	24

But it is regarded by medical specialists in infant diseases that milk is better, chemically and bacteriologically, for babies and young children if received fresh from the dairy, boiled for 4 minutes, then kept on ice till consumed. The specialist's objection to pasteurized milk for the infant is that frequently the milk is old before reaching the pasteurizing plant, it often being shipped one or two hundred miles or even further. At any rate, boiling of the milk for 4 minutes accomplishes the same purposes sought in pasteurizing. Of course orange juice should be given the child fed on milk treated by boiling, or even to the child which nurses the mother.

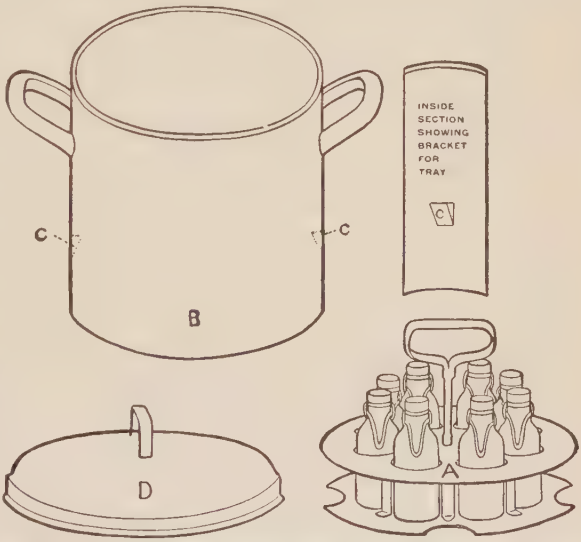


FIG. 57.—Straus Home Pasteurizer. (From Rosenau's "Preventive Medicine and Hygiene," D. Appleton and Co.)

Milk Standards.—Requirements on the part of cities and states with regard to the fat content of milk offered for sale are fairly constant. Most laws require a minimum fat content of 3.25 per cent by volume.

However, Jersey milk, especially, frequently shows fat content of 5 or 6 per cent.

But with regard to legal requirements concerning number of bacteria allowed as a maximum in milk, there is great divergence among the states and cities. Some cities have ordinances prohibiting the sale of milk containing more than 10,000 bacteria per cubic centimeter. But laws restricting the number of bacteria to such great degree are usually not well enforced, if indeed they are at all. Other cities allow a maximum of as many as 500,000 bacteria per cubic centimeter. Because of this great divergence of bacterial standards, the United States Public Health Service in recent years has drawn up a model milk ordinance and recommended its adoption by cities and states. This standard regulation has now been adopted in some fourteen states, chiefly in the South.

Grading of Milk.—Many cities grade the milk of dairies, the grade dependent on the equipment of the dairy, the cleanliness and care used in production, the bacterial count, etc. Grading of milk into several grades is regarded as stimulating dairymen in competing for the highest rating. The grades are printed on the bottle caps together with the names of the dairies. In many small cities the rating of each dairy is published monthly in the local newspapers.

THE UNITED STATES PUBLIC HEALTH SERVICE STANDARD MILK ORDINANCE

This ordinance is offered as a sort of model to cities and states. It contains the following principal provisions and requirements for production of the various grades of raw and pasteurized milk:

Grade A Raw Milk.—The bacteriological examination is made three times a month and must not average more than 50,000 bacteria per cubic centimeter. Cows must be given the tuberculin skin test at least once a year and animals found diseased must be removed at once from the herd.

Dairy (milking) barn: At least 3 sq. ft. window space for each stall; floors of concrete and washed with water from hose; manure disposed of in such a way as to prevent rearing of flies.

Milk house: Must be separate, not to open directly into the dairy barn or into any room used for sleeping or other domestic purposes; the room to be used for no other purpose than handling of milk; floor to be concrete and kept scrupulously clean by flushing with water; house to be screened against flies; water supply readily accessible, abundant, and of safe sanitary quality.

Utensils: All milk pails to have seams soldered flush or even with the general level to prevent crevices, and to be of a narrow mouth design to reduce entrance of dust or hairs from cow's flanks; utensils must be sterilized with running steam or chlorine, and after being sterilized no part which is to come in contact with milk shall touch the person or clothing of the worker.

Milking: Milker's hands must be clean and rinsed with a disinfectant approved by a health officer, then dried; wet hands not to be tolerated. Immediately after being drawn, each pail of milk must be cooled within one hour to 50° F. or lower and maintained so, even while on truck, until delivered. Capping shall be done by machinery.

Personnel: Must take medical examination and receive health certificates once a year; in case of disease of any kind in a worker's home, the health officer must be notified at once.

Grade B Raw Milk.—The bacterial count must not be more than 200,000 per cubic centimeter at time of delivery or any time prior thereto. Milk must be cooled to 60° F. or lower within an hour after being drawn. Otherwise the regulations are substantially the same as for Grade A Raw Milk.

Grade C Raw Milk.—Bacterial count not to be more than 1,000,000 per cubic centimeter. May sterilize with hot water instead of steam. No health certificates required of personnel. Milk to be sold only for cooking purposes or for pasteurization.

Grade D Raw Milk.—Maximum bacterial count 5,000,000 per cubic centimeter. Otherwise regulations same as for Grade C Raw Milk.

Grade A Pasteurized Milk.—This is Grade A or Grade B Raw Milk which has been pasteurized. Bacterial count must be not over 50,000 per cubic centimeter after pasteurization and when delivered. Must be cooled to 50° F. or lower *immediately* after being pasteurized. Health certificates required of workers at pasteurizing plant. The pasteurizing plant and methods of operation must be scrupulously clean. Floors must be of concrete and thoroughly washed. Capping of bottles to be done by machinery.

Grade B Pasteurized Milk.—This grade is Grade A, B, or C Raw Milk which has been pasteurized and the bacterial count of which after pasteurization is not higher than 100,000 per cubic centimeter.

Grade C Pasteurized Milk.—Milk which is pasteurized and which has not more than 500,000 bacteria per cubic centimeter after pasteurization.

Certified Milk.—Certified milk is milk which has been produced

under the required regulations of the American Association of Medical Milk Commissions. A medical milk committee is appointed by the local county medical society to see that the regulations of the American Association are carried out at any dairy which applies for certified standing. The local commission visits the dairy at least once a week. For certified milk all requirements are stricter than those for Grade A Raw Milk mentioned above. Not more than 10,000 bacteria per cubic centimeter are allowed. If the milk shows more than 10,000 per cubic centimeter for ten days in succession, it loses its certified standing and must then cease to label its caps as "certified."

Certified milk sells at considerably higher price than other milks and is used chiefly for infant feeding. It usually sells at about 25 cents a quart as compared with about 15 cents a quart for raw milk.

But with all the care taken at certified dairies an occasional epidemic of disease is caused by contamination of the milk by workers. Milk produced even under the strict regulations of certified dairies should be pasteurized in the home or boiled 4 minutes, if to be fed to infants.

Milk Products and Disease.—Ice cream fairly frequently is the occasion for an outbreak of disease. Even though the cream is frozen, germs of disease may live for days or even weeks to produce disease when it is consumed. Usually milk to be used for ice cream is first pasteurized, after which it should be handled with greatest care to prevent hands or persons of workers coming in contact.

Butter and the cheeses very rarely are responsible for the transmission of infectious diseases.

From all that has been said concerning the contamination of milk or milk products with germs of disease, it is readily seen that the most dangerous source of infections is the person who handles the milk. As a source of disease man himself is man's greatest enemy.

SUMMARY STATEMENT

Milk is the best single food which we possess. But unfortunately it is the most difficult to preserve. It is especially difficult to preserve because it is an exceedingly fine food for most all kinds of bacteria, both pathogenic and non-pathogenic, and because it is a fluid and any bacteria gaining entrance soon pervade the entire bulk.

Of all foods, milk is the most likely to convey disease. The only assurance against such disease is pasteurization, for even certified milk occasionally gives rise to epidemics. Not only does pasteurization kill all disease germs, but it also kills most bacteria which cause souring of

the milk and thus preserves it longer. But because milk is to be pasteurized is no excuse for allowing unclean methods in its production. It is important that honest and faithful pasteurizing be done. It is important that the pasteurizing apparatus be modern, with no " pockets " in which milk may not be heated sufficiently. It is one of the most important duties of a health department to see that milk sold as pasteurized milk is really efficiently and honestly pasteurized, which in many cases is not true.

CHAPTER XIV

CHILD CONSERVATION

Rank of the Child Conservation Problem.—Child welfare is regarded as one of the largest public health problems confronting our country, taking rank along with those of tuberculosis, venereal diseases, heart diseases and cancer.

Every year one hundred twenty thousand babies die from altogether preventable conditions during the first year of their life. There is no reason for this slaughter except the ignorance of mothers and the indifference of the communities where they live. Possibly it might make a difference if our legislatures realized that these babies have a capital value of more than $9000 if they are boys and of $4000 if they are girls, and that the capital lost throughout the country from this preventable infant mortality reaches the astounding figure of more than three-quarters of a billion dollars a year.—Dr. Louis I. Dublin, Vital Statistician for Metropolitan Life Insurance Company.

PRENATAL CARE OF THE CHILD

Thought of the health of the baby must begin long before its birth. The mother must regulate her diet so that the baby will be well nourished with a balanced supply of food. Calcium, for instance, must be supplied the unborn child for the building of bone and teeth, which begin formation months before birth. The mother must, also, refrain from work which may cause excessive fatigue to herself and devitalize her unborn baby. Work or physical exercise sufficiently strenuous to endanger the life of the child must be avoided. The health of the mother must be guarded. From time of early pregnancy she should be under the observation of a physician. Regular analyses of the urine should be made. But many thousands of mothers are entirely too ignorant to appreciate injunctions of a physician or too poor to secure the services of a physician or too poor to be able to cease work before the birth of the baby. For such mothers the visiting public health nurse, maintained by all modern county and city health departments, may be of great aid. The expectant mother may also have access to infant welfare stations

or clinics in many of our towns and cities, there to receive medical advice and education in hygiene of pregnancy.

HEALTH CARE OF THE INFANT

Infant Mortality Rates.—In speaking of the infant we refer to children under one year of age. The infant mortality varies greatly from country to country, from community to community within the same nation, or even from section to section within the same city. The infant death rate in New Zealand is a little above 40 per 1000 born, while that in the United States for the year 1924 was 82.2. In 1927 infant mortality in the United States dropped to 64.9. The infant mortality rate for Oregon in 1924 was 51 per 1000 born; that of New Mexico was 132. In 1926 infant mortality in Portland, Oregon, was 39, while that of Johnson City, Tennessee, was 160. Within a short period of five years the infant death rate of Framingham, Massachusetts, was reduced 40 per cent. These figures reveal one outstanding fact: that infants are much more neglected in some communities than in others. Some communities have even four times as high infant mortality rates as do others. This is due chiefly to ignorance and economic disadvantages.

Causes of Infant Mortality.—Among the causes of infant mortality the following may be mentioned:

(1) The employment of ignorant *midwives* at birth rather than physicians, many people being unable to have a physician's attendance.

(2) *Organic feebleness.*—In this case the child fails to inherit a robust body capable of strong reistance to the adversities of life.

Influence of Artificial Feeding on Infant Mortality

Month of Life	Deaths per 1000 Born		
	Breast-Fed	Partly Breast-Fed	Artificially Fed
1st	17	36	55
2nd	6	15	25
3d	4	13	21
4th	3	9	19
5th	3	6	18
6th	2	6	18

(3) *Unclean milk* is one of the chief causes of infant deaths, and the most preventable cause. The breast-fed baby possesses a much better chance of life than does the bottle-fed. When a baby is taken from the breast and put upon the bottle its chance of life is reduced to about one-fourth or one-third. In Nassau County, New York, 2425 babies were under observation. There were twice as many cases of illness among the bottle-fed as among the breast-fed. It was found that 71 per cent of those dying of intestinal diseases were bottle-fed. Milk of a high bacterial count produces much intestinal disorder. For some infants cow's milk does not agree, even though the milk is clean and relatively clear of bacteria.

(4) *High temperature weather* has a marked effect on infant illness and intestinal disorders, even though the infant is breast-fed. Chicago had a house-boat on Lake Michigan to which such infants were taken in hot weather. On being taken to the house-boat on the cool lake, the babies recovered almost miraculously.

(5) The *economic status* of the family is an important factor in infant mortality. Many families are too poor to purchase wholesome milk for the infant, or too poor to buy ice or an ice-box for keeping the bacterial content of the milk from multiplying greatly. Frequently in a single city it happens that the infant death rate in the poorer section is three times that in the section where the well-to-do live.

THE DECLINE OF INFANT MORTALITY IN MASSACHUSETTS

Five-Year Periods	Average Annual Deaths per 1000 Born
1910–14	117
1915–19	100
1920–24	79

The decline of the infant death rate shown in the table above for Massachusetts is typical for the United States as a whole.

Means of Reducing Infant Mortality.—The reduction of infant deaths offers the greatest opportunity for life saving and for reducing the general death rate of any possible line of effort which can be suggested by present scientific knowledge.

(1) An important item in reducing the infant death rate is the education of mothers to the great importance that the infant be breast-fed

when possible. Many mothers nowadays put their babies on the bottle for convenience to themselves.

(2) One of the most productive means of reducing infant mortality is the provision of clean and wholesome milk for the bottle-fed. Careful supervision of dairies to insure production of milk in cleanly manner; pasteurization of all milk given to infants; provision of ice for the poor to insure milk of a low bacterial count; milk stations where milk of known quality may be retailed; education of mothers as to clean methods of feeding the baby—all these may be made to contribute toward reducing infant mortality.

(3) Another fruitful means of reducing infant mortality is the establishment and maintenance of baby clinics, where the mother may take her child for diagnosis, for advice and general education with reference to child care. At such clinics lectures at stated periods are given by physicians and nurses for the benefit of mothers, and pamphlets on phases of infant care are given out.

(4) Day nurseries are maintained in many cities by charitable organizations; to these the working mother may take her child for efficient care and feeding during her work hours.

HEALTH CARE OF THE PRE-SCHOOL CHILD

As a matter of history, the infant welfare work and the work in the interest of the health of the school child developed first. The birth of the infant secured entrance to the home by the doctor and the public health nurse and gave them an opportunity to offer aid in solution of the health problems of the infant. The school offered opportunity to the health workers to reach the child of school age without going to the home of the child. But the child of pre-school age was more difficult to reach. Hence, an attempt to reach the pre-school child is of more recent origin than those to reach the infant and the child of school age. The pre-school child was longer neglected than those of other ages.

Needs of the Pre-school Child.—The pre-school child may be defined as that between the ages of 1 to 6 years. Drs. Wood and Rowell have well pointed out the needs of the child at this period.

(1) This is the period of life when immunity is at its lowest level, and in the early part of this age is the time when the child should be immunized to diphtheria, scarlet fever, smallpox and typhoid.

(2) The teeth in this period of life are likely to be in great need of frequent dental inspection. Neglect of teeth and dental hygiene may influence the health of the child's permanent set during all his life.

(3) Eye defects should be detected and proper glasses prescribed. Crossed eyes should be corrected in this period of life.

(4) Tonsils and Adenoids which are enlarged or infected are most profitably removed at this time.

(5) The pre-school child should be regularly weighed and measured. Those of underweight condition should be scientifically fed on a balanced ration rich in milk. In the diet should be a variety of fresh vegetables and fresh fruits.

(6) Rickets may develop during this period of childhood. To avoid this disease and abnormality the balanced diet should be given. Also cod-liver oil, under the direction of a physican, should be had regularly. Furthermore, sunshine upon the bare skin must be supplied the child, this also under suggestions of the doctor.

Agencies Which Aid in Promoting Health of the Pre-school Child.—

(1) Baby health contests sponsored by many types of organizations have contributed much to correction of physical and health defects found in children and in the education of parents along such lines.

(2) Nursery schools in many cities provide general physical care and medical services for children.

(3) In rural sections the county health department conducts examinations of pre-school children at community fairs or at meetings sponsored by the women of church organizations, parent-teacher associations, etc.

(4) The kindergarten is for the older of the pre-school age. Even nere health habits formation is begun but not much medical or nursing service is provided as yet.

(5) Campaigns for corrections of physical defects some months before the child is to enter school have been conducted throughout the nation by various agencies. This campaign and the child examinations program have reached even villages of more remote sections.

HEALTH CARE OF THE SCHOOL CHILD

In the more progressive schools regular school physicians, dentists, and nurses are employed. The children are given health instruction and training in the establishment of health habits. Physical examinations and correction of defects are provided. The child is weighed and measured and suitable lunches are furnished. He is further protected by careful control of communicable diseases. Corrective gymnastic exercises and treatment for physical defects are offered. Special classes for the mentally dull and highly alert obtain.

Since we are to consider the health of the child in a subsequent chapter on the school health program, we shall dismiss the subject for the present with this brief statement.

HEALTH CARE OF THE CHILD IN INDUSTRY

Industry must not be allowed to sap the physical energy of the child or youth nor to stunt his mental development and education. This is for the good of the individual and for his happiness in life. It is also imperative for the good of society and the state.

The Child-slave of the Cotton Fields.—There are numerous industries which offend against the child. Among them are the cotton fields of our Southern States. In these fields many children, even down to five years of age, spend most of the 24-hour day during the cotton harvesting season. Heavy loads of cotton in sacks hang from their shoulders throughout a long work day under a broiling summer sun. The author, in the small community where he spent his childhood, has known dozens of children under ten years of age to doze upon their cotton sacks in the fields awaiting daybreak and sufficient light to begin their day's deadening drudge. The children toiled at the hard labor of a convict throughout a long scorchingly hot day whose dusk it seemed would never come. When these children reach young adulthood, aged, haggard expressions, bent bodies, stunted mentalities, and dwarfed ambitions are their portions and rewards.

The owners of the cotton fields seek the tenant farmer who possesses a "force." The larger the number of children comprising the "force" the greater the likelihood of the tenant's receiving shelter for self and family for a twelve-month, sorry shelter though it may be.

It is a rare instance that the Southern rural school continues for longer than seven months per year, even in this day. The chief, indeed the only, reason advanced for the short school year is, the children are needed for cotton picking in the autumn and for cotton "chopping" in the spring. Even in our Southern States the children have to some degree been emancipated from the cotton mills by poor legislation poorly enforced, but the child-slaves of the cotton fields continue unnoticed, the state's disgrace and the nation's liability.

Another which would take its toll of child life is the textile industry. Until recent years children of even pre-school age were worked in cotton mills in an atmosphere of floating dust and lint, which, of course greatly militated against physical and mental development. Poorly lighted and poorly ventilated as were the rooms, the fatigued child fre-

quently became the victim of disease. The child of the cotton mills has not been fully emancipated.

Desirable Regulations for Children in Industry.—Among the recommendations of the Federal Children's Bureau as requirements regarding the working child are the following:

(1) That no child under 16 years of age shall be employed in the industries. The minimum of 16 is named because of pubescence extending from about 13 to 16. This period is one in which there is great physical and mental stress and development, and for these the boy or girl needs all energy available.

(2) That the employer provide a medical examination once a year for such child, the physician not to be chosen by the employer.

The regulation of requirements concerning the child in industry is at present left to the state governments. Most states at present have child labor laws on the statute books, but in some states the enforcement is poor.

In most states hours of employment are limited, from 48 to 60 hours per week. Usually, also, the states require that a child in industry must have attained a certain minimum education. Most states fix the minimum age for entrance into industry as 14 years.

CHAPTER XV

PUBLIC HEALTH ADMINISTRATION

Definition.—Public health administration is that portion of the government—local, state, or national—which endeavors to protect and improve the physical welfare of the citizens. It considers and deals more with the mass of persons than with the individual. Public health authorities seek to perform two services to their communities or jurisdictions:

(1) To *promote* the health of the people, and
(2) To prevent and control diseases among them.

The health promotion is carried on chiefly by educating the people through newspapers, pamphlets, lectures, pictures, etc., as to care of selves in order that they may possess the highest degree of physical and mental efficiency and the greatest degree of enjoyment of life. It is already learned from Part I of this text how health officials seek to prevent the various diseases.

THE ORGANIZATION AND WORK OF THE CITY HEALTH DEPARTMENT

What the City Health Department Does.—The American Public Health Association is a private organization composed largely of health officials and of professors of public health in colleges and universities. This Association is the accepted authority on efficient and progressive public health practices in North America. The American Public Health Association has outlined the duties of a city health department. The Association has also designated the number of scores or credits which may be assigned to a duty or phase of the work of a city health department when that duty is performed fully and in a highly efficient manner. The total possible scores or credits which may be attained by a health department is 1000 points. Below we shall consider the various phases of public health work incumbent on a progressive city health department as seen by the American Public Health Association.

(1) *Vital Statistics* (60 credits allowed for efficient system of vital statistics).—Vital statistics deal with statistics relating to life, the term " vital " pertaining to life in its root meaning. Vital statistics relate to marriage, divorce, births, number of deaths and from what diseases, and with sickness. Vital statistics, properly obtained and kept, inform us where we have been and where we are going, speaking in terms of community health. For instance, looking back over the vital statistics compiled by the U. S. Bureau of Census, we find that the death rate from tuberculosis, all forms, in the year 1900 was 201.9 per 100,000 population and that the death rate from the same cause in 1924 was 90.4 per 100,000 population. Again, the death rate from heart disease, in 1900 was 132.1, while that of 1924 was 178.1. This information tells us that our efforts to reduce tuberculosis are bearing fruit and that we should continue effort along the same line. It also tells us that heart disease is on the increase, and that we must make a study of that field and direct effort toward that quarter. The collection of vital statistics in any given community is not up to standard if it does not record at least 90 per cent of births and 90 per cent of deaths. Such statistics are collected from physicians, midwives, and undertakers.

The U. S. Registration Area for Births includes those states and cities reporting at least 90 per cent of births occurring. Likewise, the Registration Area for Deaths include those states and cities which are reporting at least 90 per cent of deaths. Only a small proportion of the population of the United States is outside the Registration Area for Deaths and a slightly larger proportion is not within the Area for Births. The States which in the summer of 1928 were outside the Registration Area for Deaths are Nevada, New Mexico, South Dakota, and Texas. Those outside the Registration Area for Births include the states named above and the states of Colorado and South Carolina. All these states undoubtedly will soon enter both Areas.

(2) *Control of Communicable Diseases* (175 points possible).—Reporting of communicable diseases by physicians is an important and basic necessity before control of diseases can be exercised. When an outbreak of communicable disease occurs the public health machinery is put into motion for the prevention of further spread. Measures for prevention are constantly at work in the health offices, although perhaps not apparent to the average citizen.

(3) *Venereal Diseases Control* (Possible rating of 50 points).—Syphilis and gonorrhea are reportable by physicians to the health officer. Because of the peculiar nature of the venereal disease problem, it

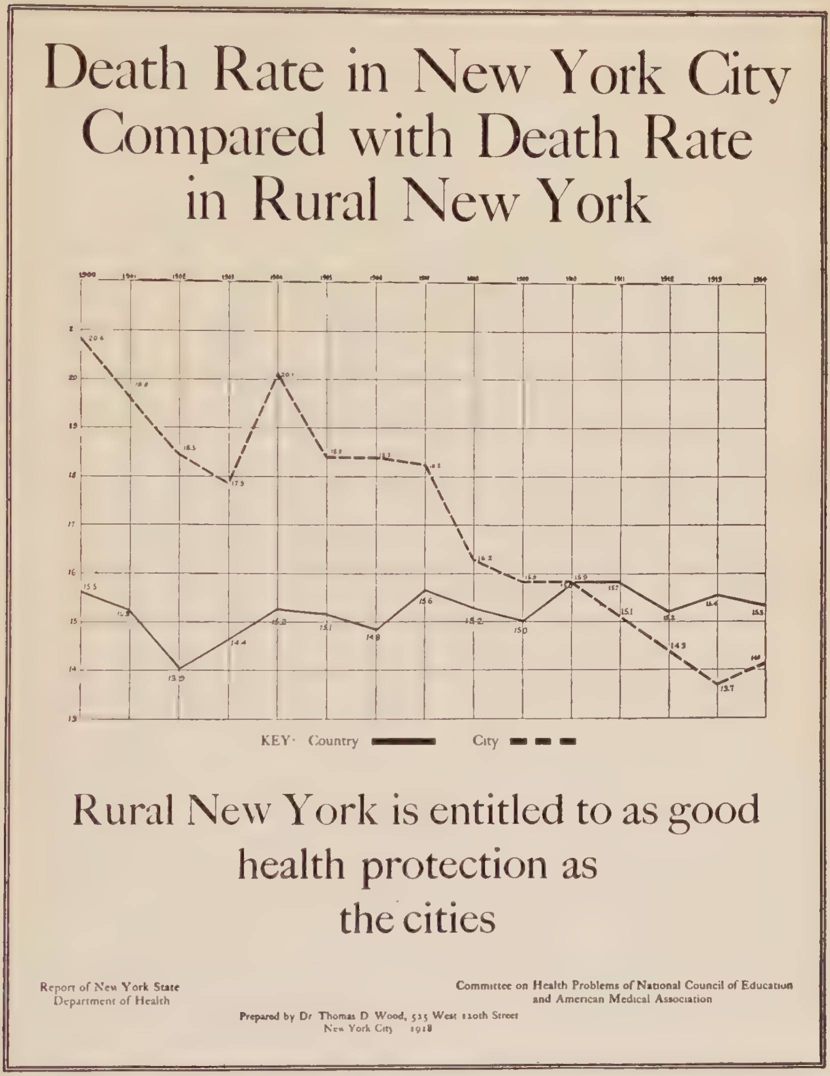


FIG. 58.—A study in vital statistics. This reveals a fact which shows that New York State, and the United States as a whole, no doubt, should give more attention to public health in rural communities. This is illustrative of the value of a well-kept system of vital statistics. Statistics show what ought to be done and whether our methods of the past have been effective. (By courtesy of Dr. Thomas D. Wood, Teachers College, Columbia University.)

is considered separately from the other communicable diseases, discussed above.

(4) *Tuberculosis Control* (100 points).—Because of the widespread nature of tuberculosis and because of its possible high degree of prevention and cure, it, too, is mentioned separately from other communicable diseases.

(5) *Health of the Child* (350 points).—Conservation of child life offers the greatest opportunity under present state of knowledge to reduce average death rates. Some communities have infant death rates four times as high as those of others, due to negligence. Because of the large possibilities in child health care, the community is offered the large number of 350 points in credits if it appears to be making the most of its opportunity in saving child life. Of the 350 points, 200 are allowed for perfect effort in the care of the pre-school child and 150 points for the care of the child in school.

(6) *Sanitation:* Foods and Milk Inspection; Water Purification; Sewage Disposal (total 175 points).

(7) *Laboratory* (70 points).—The laboratory makes bacteriological examinations of water and milk, of sputa suspected of being tuberculous, of smears or swabs from suspected cases of diphtheria, etc.

(8) *Popular Health Instruction* (20 points).—Such instruction is given by means of lectures, conferences, motion pictures, pamphlets, newspaper articles, etc.

Casting back through the outline of the duties of a city health department as conceived by the American Public Health Association, note which of the eight items are given the highest number of points for perfect performance of duty and which the lowest. Which of the eight items are regarded as the most important, judging from the number of credits assigned?

City Health Officials and Their Duties.—For a town of 25,000 population, Professor Rosenau suggests the following organization of personnel.

One health officer
One epidemiologist
Three public health nurses
One milk and dairy inspector
One sanitary inspector
One statistical clerk
One stenographer

The above does not include the medical, dental and nursing personnel for the public school system.

The health officer is the executive. He should possess both medical and public health training. Perhaps most health officers do not at present possess public health training.

The epidemiologist is a specialist in the subject of how outbreaks of disease originate and disseminate. He plans methods to prevent outbreaks, and in case one occurs from an unexplained or unforeseen cause, he lays plans to find the source of the outbreak and to stop its further spread.

A public health nurse is one who is a graduate nurse and who also has had a year of training in sociology and public health subjects in a recognized university offering those courses. She visits the homes and gives instruction in prenatal care of the child, and in the care of the child of the pre-school age. She aids in control of outbreaks of communicable disease by teaching patients and their families the hygiene of prevention of further spread. Some public health nurses devote their whole time in the public schools aiding teachers in health training of pupils.

The milk inspector visits dairies, creameries, and pasteurizing plants to see that hygienic methods are used and all regulations carried out.

The statistical clerk is one who is trained in vital statistics and who keeps the records of births, deaths and causes of the same, sickness, marriage, and divorce.

Larger cities, of course, have a larger personnel than the one mentioned above while smaller ones may have a reduced number of employees in the health department.

THE COUNTY HEALTH UNIT OR DEPARTMENT

The standard county health department (or unit) has been largely the development of the Rockefeller International Health Board, which contributes one-fourth of the expense for salaries of a unit having the following organization of personnel: A health officer, a public health nurse, a sanitary inspector, and a stenographer. The officials have much the same duties as those of the city health officials, with special attention given to rural sanitation—methods of obtaining safe water supplies, safe sewage disposal for country homes, prevention of flies and mosquitoes, etc. (Fig. 59). Such officials also urge the people to immunize against smallpox, typhoid, scarlet fever and diphtheria. They spend considerable time among the schools of the county examining children, making recommendations for removal of defects and in "follow-up" visits to see that recommendations are carried out by parents. They also enlist the aid of teachers in the school health work.

In recent years it is becoming the practice for two or more counties that are poor economically to join in the maintenance of a single health unit for the several cooperating counties.

Rural communities have made but little progress in health promotion and disease prevention. For this reason they offer much greater opportunities for health service than do the cities, which have already made great progress.

STATE HEALTH DEPARTMENT

At the head of the State Health Department is a state health officer or director of public health. He is the executive. In some states the

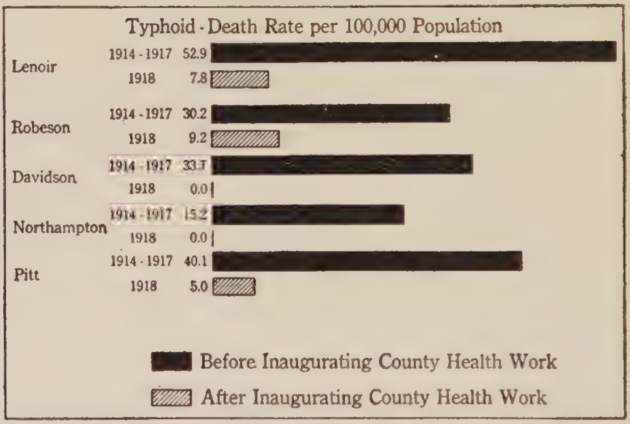


FIG. 59.—The value of full-time county health units (departments in five counties of North Carolina). (From Dr. John A. Ferrell.)

health officer is appointed by the governor; in other states, he is appointed by a state health board, composed chiefly of physicians.

The work of the state health department is divided among bureaus. The names of the bureaus as they usually occur in state health departments will indicate their functions. Usually the bureaus are: Bureau of Venereal Diseases; Bureau of Communicable Diseases; Bureau of Vital Statistics; Bureau of Pure Foods and Drugs; Bureau of Rural Sanitation; Bureau of Sanitary Engineering; Bureau of Child Welfare; Bureau of Laboratories, etc. There are in each bureau a head official and perhaps several assistants, clerks and stenographers.

Among the functions of a state health department are: Coordination of the work of the city, county, and district health officials; aid to local health officials in control of epidemics which may occur; rendering

expert advice to local governmental and health officials in matters regarding methods of prevention; education of the public along health lines by distribution of free pamphlets and by other methods; advising the Legislature as to what health laws and regulations are desirable; enforcement of state health laws.

THE UNITED STATES PUBLIC HEALTH SERVICE

The United States Public Health Service Bureau inspects immigrants for disease; quarantines ships entering our ports; controls interstate quarantine; sets up standards for the manufacture of vaccines and serums and sees that manufacturers of those products conform to such standards; aids state and local health authorities in controlling epidemics, when invited to take part; and conducts research in public health problems of the United States.

THE UNITED STATES BUREAU OF EDUCATION

The Federal Bureau of Education publishes many excellent bulletins or pamphlets of interest to teachers of health in the public schools. The bulletins are sold at a few cents each. A printed list of these publications may be had free by addressing the Superintendent of Documents, Washington, D. C.

THE INTERNATIONAL HEALTH BOARD

The International Health Board, an endowed Rockefeller institution, New York, is a private philanthropic agency of public health. The International Health Board conducts research work in various fields of public health; and demonstrates, for benefit of state and local governmental officials, advanced methods of disease control, methods for eradicating malaria and hookworm, for instance. It bears one-fourth of the expense of standard county health departments (or units). But the International Health Board does not confine its activities to the United States; its humanitarian activities extend to many foreign countries. This Board's progressive work, though largely unseen by the average citizen, is perhaps the one most powerful influence in the elevation of man's physical well-being in all parts of the world. It spends many millions of dollars per year for humanity's physical welfare. The Board works largely through national, state and local governments, allowing them the credit for whatever is accom-

plished. The most spectacular deed accomplished by the International Health Board was the recent eradication of yellow fever from the Western Hemisphere, the story of which has been related previously. This almost unseen friend of humanity is one of the most conspicuous examples in all history of utterly unselfish endeavor for human kind, without even the desire for credit.

But the International Health Board expends money on a county health unit only when the local county authorities establish a thoroughgoing, worthwhile health department. Inquire of your county officials whether a portion of the expense of your county health unit is paid by the International Health Board.

THE AMERICAN PUBLIC HEALTH ASSOCIATION

The chief authority of North America in science of public hygiene is the American Public Health Association, headquarters at New York City. This organization is composed of public health workers of many kinds, but chiefly of city, county and state health officials and university professors of public health subjects. This association carries on research in public hygiene, encourages adoption of improved methods of protecting the citizens against disease, and publishes a monthly journal, the *American Public Health Journal*, and many pamphlets and books relating to public health.

THE AMERICAN MEDICAL ASSOCIATION

The American Medical Association maintains a public health section in its annual meetings; publishes much material on public hygiene in its weekly journal and in pamphlets and books. A unique feature of its work is the exposure of " patent " medicine frauds and advertising medical quacks who make glowing promises of impossible cures. It publishes *Hygeia*, which is the best non-technical journal available on matters relating to personal health. This association is the national organization of physicians and surgeons and has headquarters at Chicago.

THE AMERICAN DENTAL ASSOCIATION

The national organization of the dental profession maintains headquarters at Chicago. Considerable literature on oral hygiene may be had from this association.

THE NATIONAL TUBERCULOSIS ASSOCIATION

The National Tuberculosis Association, New York, was organized a quarter-century ago for the specific purpose of combating tuberculosis, without, however, confining its public health work to tuberculosis alone. This association has branch organizations in most states, usually known as public health associations. There are also many county organizations belonging to the superior national association. The purpose of the national association and its state and county branches is to encourage establishment of special hospitals for the tubercular; conduct clinics for tubercular suspects in particular, but not confining its activities to this class of patients only; and educate the public in matters of hygiene through newspapers, pamphlets, motion pictures, etc. The association sponsors the " Health Crusaders " among children of the public schools. The National Tuberculosis Association is supported by the sale of Christmas Seals, sometimes improperly called " Red Cross " seals.

THE AMERICAN RED CROSS

The national organization of the Red Cross not only does nursing service in war but does much public health work also in times of peace. The public health work of the Red Cross is done mostly in the wake of disasters, such as great floods, fires, and destructive wind storms. It also maintains nursing and nutrition services for public schools and for the instruction of mothers in feeding and care of the child. Since the World War the local chapters of the Red Cross have aided many thousands of veterans in obtaining medical aid from the federal government in cases of injury or disease resulting from their service in the European War. The Red Cross derives its financial support from its annual " Roll Call " of members, most members paying a dollar each.

THE AMERICAN CHILD HEALTH ASSOCIATION

The American Child Health Association, headquarters in New York City, is the leading non-governmental organization of the country which has interested itself especially in child welfare. The Association makes special investigations relating to the health of the child, of both preschool and school ages. At the present time the association is conducting a research project reaching 70 cities in the United States and consisting of an inquiry to learn just how effective is the health teaching of

the public school in developing dependable health habits in the daily life of the children. Recently this association conducted a survey in nearly a hundred cities of the United States to ascertain the public health practices actually prevailing in this country. The publication of the results of this survey is regarded as a classic in American public health literature. Perhaps the American Child Health Association publishes the finest literature available from any source for the teacher who is interested in health training.

From each of the associations mentioned above a printed list of its publications may be obtained free on request. The publications are sold at cost of printing; they are especially useful to teachers.

CHAPTER XVI

THE PUBLIC SCHOOL HEALTH PROGRAM

For a number of years past we have been hearing that the health of the school child is, or should be, the chief concern of the school. As yet, however, the schools attended by the majority of our children have not admitted the truth of the statement, if we judge by the activities of those schools. A nation with the maximum physical, mental and spiritual possibilities can not be attained so long as physical, mental and spiritual training of all the children does not pervade all the school system from the first year to the last. What we would have the nation become must be sought through the schooling of the people, and the schooling must be continuous from the first to the last year. If we would have a nation of the maximum health possible, then health training and health promotion must pervade the entire curriculum, just as does English in order to establish correct expression of thought.

The complete school health program may be said to embrace five activities on the part of the school: (1) health instruction of the pupil; (2) establishment of dependable health habits in the pupil; (3) operation of the hygiene of the school plant; (4) control of communicable diseases in the school; (5) health service provided for the pupil. In a text-book of the nature of this it is impossible to give extended space to all the five health activities of the school here mentioned, but the fundamentals of each of the five will be briefly outlined in this chapter.

I. HEALTH INSTRUCTION

Health Instruction to be Done by the Teacher.—Instruction of the pupil in matters relating to health should be done by the classroom teacher, not by a nurse who visits the classroom occasionally. It can be done more effectively by the teacher, by the same person who later is to insist on the health information of the pupil being carried over into established health habits. Every teacher of the school must be qualified in scientific training and in personal health practices for the task.

Subject Matter and Health Instruction in the Lower Grades.—Health instruction methods vary much with the age and advance-

ment of the pupil. In the lower grades such instruction consists merely in learning rules of health, with no attempt on the part of the teacher at scientific explanation of the *why* of those rules. Reasons for them do not occur to the mind of the child in the lower grades. The child's mind has no need for reasons, and does not acquire the reasons when

FIG. 60.—A health poster made by a boy in the second grade.

they are offered. Health laws taught in the lower grades deal with personal hygiene only.

As devices to aid in the teaching process health songs, dramatizations of principles relating to hygiene, health jingles, rhymes and poems, and posters (Fig. 60) made by the children to illustrate health facts or principles are frequently used. The songs, dramatizations, posters,

etc., offer an opportunity to repeat the lesson in a different form of presentation. As still another method of objective teaching, the pupils may be allowed to operate certain items in the hygiene of the school plant. They may be allowed, for instance, to regulate the ventilation of the schoolroom or to regulate the heating of the room, observing a well-placed thermometer.

Only one lesson in several days or perhaps only one per month may be taught. The following are illustrative of some of the more important lessons to be taught in the lower grades:

The importance of drinking a pint to a quart of milk each day, with no coffee or tea.

The importance of sleeping ten to twelve hours, in a cold room in winter or in room with slowly circulating air (through window) in summer.

The need of cereals, vegetables and fruits each day.

The need of several glasses of water each day.

The importance of total abstinence from sweets, except at the end of meals.

The need of brushing the teeth at least twice a day.

The need of washing the hands before each meal.

The need of play in the sunshine each day.

The importance of a regular toilet hour each day.

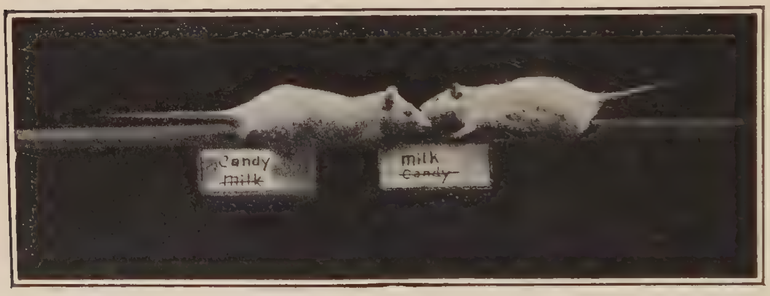
As stated above only one of these lessons may be taught per month. But the lesson may be repeated, as stated, with dramatization, song or poster, health poems, rhymes or jingles.

Plentiful supplies of stories, songs and plays may be had from either of two excellent books published by the National Tuberculosis Association, New York City. Those books are Wootten's "Health Education Procedure for the Grades and Grade Teachers," and Dansdill's "Health Training in the Schools: A Handbook for Teachers and Health Workers." Both of these books should be in the hands of every grade teacher.

Subject Matter and Methods in the Upper Grades and High School.—In the upper grades and in the high school the subject matter consists of personal hygiene, home hygiene, and school and community hygiene. The pupil at this age begins to conceive himself as a part of a company or a part of a community and is able to consider the relation of himself to the group or community. It is at this age that he begins to become conscious of himself as a part of society. He can now begin to think in terms of the common good of all. He is able to see the relation of personal health to the health of the community. Furthermore, he is now demanding reasons for health regulations. He now asks questions of *why* and may now be led into elementary scientific reasoning. Principles of health are now reasoned about. They are no longer mere rules to be accepted without reasons.

The student is now capable of appreciating elementary laboratory work illustrative of health facts or principles. He can now with great profit observe with a microscope the living, wriggling bacteria and protozoa in a drop of water from a hay infusion. He can appreciate the methods of cleanliness, or lack of cleanliness, used in a dairy establishment which he may visit. He appreciates an investigation in the chief causes of illness and death in his community. Simple laboratory exer-

A



B

FIG. 61.—Milk *versus* Candy. An animal feeding experiment which may be done by school children. In the upper photograph the rats are 7 weeks old. The one on the left had been fed milk as a special food while the one on the right had received candy as its special food. In the lower figure the same rats are shown 3 weeks later, after the special foods had been reversed, as shown by the tags. (By courtesy of Miss Jeanie Pinckney, University of Texas.)

cises and field work are very profitable methods of instruction for the student at this age and stage of advancement. With the aid of laboratory and field work a much stronger impression is made on the mind than with reading and classroom work only, and knowledge gained in this way by the pupil is much more likely to become a part of himself as attitudes of mind and as health-promoting habits.

Below is a quotation from the U. S. Public Health Reports which illustrates the highly instructive character of some of the field work which can be devised for pupils in the upper grades and high school.

In Dunklin County, Mo., the county health officer induced the pupils in the biology class of the local high school to make a sanitary survey of Senath, a town with a population of about 2000, but without a public water supply or sewerage system. The survey form used was as follows:

DUNKLIN COUNTY HEALTH DEPARTMENT

Cooperating with

STATE BOARD OF HEALTH OF MISSOURI AND UNITED STATES PUBLIC HEALTH SERVICE

Sanitary Survey of Senath, Mo.

Made by the Senath High School Biology Class

Date, March, April, 1925

A. *Water supply.*

(1) Public water supply: Source............ Treatment, if any............ Result, analyses............ Number of service connections............ Number having connections using city water for drinking purposes............

(2) Private water supplies: Type—Driven............ Drilled................ Dug............ Bored............ Cisterns............ Total........ Good surface drainage: Yes............ No............ Concrete platform: Yes............ No............ Waste water trough: Yes........ No............ Distance from privy, cesspool, or pollution: Over 100 feet............ 50 to 100 feet............ Less than 50 feet............ Number of houses and buildings having pressure water supply.............

B. *Excreta disposal.*

(1) City sewerage system: Outlet............ Treatment, if any............. Number of houses with access to sewers............ Number without............ Number connected to sewers............ Per cent connected of those having access to sewers............ Per cent connected to total number............

(2) Number of houses having private sewage disposal system............ Type: Cesspools............ Septic tank............ Outlet: Surface (unsafe)............ Underground............

(3) Outdoor toilets: Type—Surface............ Pit type............ Septic privies............ Other types............ Total............ Flyproof (tight seat box and seat lids)............ Not flyproof............ Contents accessible to domestic animals (open back)............ Inaccessible............

C. *Malaria prevention.*

(1) Condition of screening of houses and buildings: Good (with no holes—well-fitted and with all wire No. 16, or No. 14, painted............ Fair............ Poor............

(2) Breeding places and shelters for mosquitoes: Low places and ditches in which water pools—Not oiled............ Oiled............ Open rain barrels............ Tin can dumps............ Open wells............ Shelters of brush and high weeds not cleared or cut............

(3) Breeding places outside city within one mile: Swamp area—Extent............. Obstructed ditches................ Pools............

(4) Mosquito control measures in force: Ditching............ Ditch maintenance............ Oiling............ Top minnows............

D. *Garbage disposal.*

Provision for regular collection............ Number of houses and buildings using regular service............ Number using private disposal: Burning............ Burying............ Surface of ground............ Feeding fowls or hogs............

E. *Manure disposal.*

Number of places keeping horses, mules............ Cows............ Number of places removing manure at least weekly during warm weather to prevent fly breeding in city............ Number not doing so............

The interest aroused by this survey along with other factors set in operation by the county health department resulted in the calling of an election which was carried by an overwhelming majority for the installation of a public sanitary water supply and sewerage system.

II. HEALTH HABITS FORMATION

We have mentioned that one of the five health activities of the modern school is that of developing dependable health habits in the life of the pupils. Health habits should be established while the child is in the lower grades, for the lower grades period is one of the greatest habit formation periods in life.

History of the Health Habits Movement.—There is no necessary correlation between health knowledge and health practices. Our first effort toward health training in the schools of this country came with the establishment of physiology as a part of the school curriculum. Physiology in the school came about as a result of the influence of Thomas Huxley, who was trained as a physician. Later the sciences of hygiene and sanitation developed out of Pasteur's remarkable work with bacteria, and they were included with physiology in the curriculum. The inclusion of hygiene and sanitation as a part of the school study in the United States was largely through the influence of Professor Sedgwick, of Massachusetts Institute of Technology. But after several years of teaching hygiene and sanitation it was observed that the mere possession of health knowledge by the pupil did not insure his putting into practice his knowledge of the health laws. He did not necessarily develop health-promoting habits as a result of his study of hygiene. This failure led in recent years to an effort on the part of teachers not only to instruct in laws of health, but also to an effort to establish health habits in the pupil.

Psychology of Health Habits Formation.—Health habits, like all habits, are best established in the mind while young, flexible and impressionable. Health habits, like other habits, develop as a result of repetition. Unending repetition is the price for a habit. To establish a given health practice as an indelible part of a pupil's daily routine of life requires persistent, never-ending insistence on the part of *all* his teachers. There is excellent scientific reason why the pupil should make it a practice to keep fingers away from the mouth, nose and eyes, but the teacher can not establish such practice as habitual in the child without continual insistence and persistence.

In the formation of health habits in pupils of the lower grades various forms of appeal to pride are effective. Daily inspection of pupils

for cleanliness by the teacher and by the pupils appointed from the class are frequently used as a highly effective measure. The inspection is the most effective device available. As the pupils enter the schoolroom in the morning the teacher, or some appointed student, observes for clean hands, ears, brushed teeth, etc.

Exercise and physical training, including corrective exercises, are here regarded as a part of the effort to inculcate dependable health habits. The training of the pupil to select a balanced meal from the school lunch, with certain amount of aid and restriction, may also be regarded as a portion of health habits formation.

It has been mentioned previously that perhaps only one lesson in laws of health may be taught per month. After the learning of that lesson by oral instruction of the teacher, by songs, plays, poster making, or stories, the truth of the lesson learned is then put into practice in the daily life of the pupils. All through the month, every day, the teacher is insistent on the practice of that truth. Its practice must become a habit. When the next month's lesson is learned and then practiced, the practice of this month's lesson is not to be relinquished. The habit begun this month continues to be repeated throughout the year, and during the years to come.

Parents are to be encouraged to lend their aid in the formation of health habits. They are expected to see that the children get 10 to 12 hours sleep daily, that they drink two glasses of milk per day, brush the teeth regularly, play in the sunshine, etc.

III. CONTROL OF COMMUNICABLE DISEASES IN THE SCHOOL

In Part I of this book we considered the early diagnostic signs of the various " children's " diseases, the period of incubation, period of communicability, and suggestions for exclusion of infected or exposed pupils from the school and for their re-admittance to school.

For the control of communicable diseases in the school the following named facts must be known of any given disease in question: (1) the source of the causal agent; (2) route of exit of the causal agent from the body of the patient or carrier; (3) route of entrance of the causal agent into the body of a prospective patient; (4) the agent or agents of transmission; (5) the incubation period; and (6) the period of communicability.

It is proper here to remark that the time at which a child who is known to be a susceptible " contact " should be excluded depends on the *minimum* length of the incubation period of the particular disease under consideration. For instance, the incubation period of diphtheria is 2 to

NEW YORK STATE

COMMUNICABLE DISEASES

By________________________Commissioner

RULES FOR ISOLATION AND

Disease	Principal Signs and Symptoms	Method of Infection	Exclusion from School: Patient	Other Children of Same Household: Non-immunes	Other Children of Same Household: * Immunes	Other School Children Especially Exposed: Non-immunes	Other School Children Especially Exposed: * Immunes
CHICKENPOX	Rarely begins with fever. Rash appears on second day as small pimples, which in about a day become filled with clear fluid. This fluid becomes yellow colored, a crust forms and the scab falls off in about 14 days. Successive crops of papules appear until tenth day.	Contact with discharges from nose and throat of a patient.	Yes	Yes	No	Yes	No
DIPHTHERIA	Onset may be rapid or gradual. The back of the throat, tonsils, or palate may show patches. The most pronounced symptom is sore throat. There may be hardly any symptons at all.	Contact with discharges from nose and throat, occasionally by drinking infected milk.	Yes	Yes	Yes	Yes	Yes
MEASLES	Begins like cold in the head, with running nose, sneezing, inflamed and watery eyes and fever. Mulberry-tinted spots appear about the third day; rash first seen behind the ears, on forehead and face. The rash varies with heat; may almost disappear if the air is cold, and come out again with warmth.	Contact with discharges from nose and throat of a patient.	Yes	Yes	No	Yes	No
MEASLES (GERMAN)	Illness usually slight. Onset sudden. Lymph nodes in back of neck enlarged. Rash often first thing noticed; no cold in head. Usually have fever, sore throat, and the eyes may be inflamed. Rash sometimes resembles measles and scarlet fever, variable.	Same as above.	Yes	Yes	No	Yes	No
MUMPS	Onset may be sudden, beginning with sickness and fever, and pain about the angle of the jaw. The parotid glands become swollen and tender. Opening the mouth is accompanied by pain.	Same as above.	Yes	Yes	No	Yes	No

* Immunes are those who have had the diseases, or in smallpox,

DEPARTMENT OF HEALTH

AMONG CHILDREN

EXCLUSION FROM SCHOOL

Issued by the Division of Public Health Education

Duration of Exclusion from Date of Onset					
Patient	Patient goes to hospital: Other children of the same household	Patient remains isolated at home: Other children who remain at home	Patient remains isolated at home: Children who leave household as soon as disease is discovered	Children exposed at school	Remarks
Until all scabs are shed and disinfection of person; at least 12 days.	Exclude if non-immune until 21st day after child last saw patient.			Exclude from school if non-immune during 11th to 22d days after child last saw patient.	A mild disease seldom any after effects.
Until patient is recovered and has two cultures from throat and nose which contain no diphtheria bacilli; cultures not to be taken until 9 days from date of onset. Disinfection of person.	Until two cultures at least 24 hours apart are reported negative. Those showing diphtheria bacilli should not necessarily be immunized unless symptoms appear.				Very dangerous, both during attack and from after effects. When diphtheria occurs in a school all children suffering from sore throat should be excluded and the health officer notified. The medical school inspector or health officer should take cultures from all inflamed throats and noses. There is great variation of type, and mild cases are often not recognized, but are as infectious as severe cases. There is frequently no immunity from further attacks.
Until recovery and disinfection of person; at least 7 days from onset.	Exclude non-immunes until 15th day after child last saw patient.			If non-immune exclude from school during 8th to 15th day after child last saw patient.	After effects often severe. Period of greatest risk of infection three days before and after the rash appears. Great variation in type of disease. Dangerous in children under 2 years of age. During an outbreak all children having a temperature over 99° F. should be sent home and the health officer notified.
Until recovery and disinfection of person; at least 8 days	Exclude if non-immune until 22d day after child last saw patient.			Exclude from school if non-immune during 11th to 22d days after child last saw patient.	After effects slight. Regulations strict, because frequently confused with scarlet fever.
Two weeks after onset and one week after disappearance of swelling and after disinfection of person.	Exclude 15th to 22d day after child last saw patient.			Exclude from 15th to 22d day after child last saw patient.	Seldom leaves after effects. Very infectious. Inflammation of genital organs of male or female may occur.

who have been successfully vaccinated within a year.

COMMUNICABLE DISEASES

Disease	Principal Signs and Symptoms	Method of Infection	Exclusion from School				
			Patient	Other children of same household		Other school children especially exposed	
				Non-immunes	* Immunes	Non-immunes	* Immunes
Poliomyelitis (Infantile Paralysis)	Onset sudden, fever, excitable, pain on bending neck forward, pain on being handled, headache, vomiting. Sometimes sudden development of weakness of one or more muscle groups.	Contact with discharge from nose, throat or bowels of a patient or carrier.	Yes	Yes	Yes	Yes	Yes
Scarlet Fever	The onset is usually sudden, with headache, fever, sore throat, and often vomiting. Usually within twenty-four hours the rash appears as fine, evenly diffused, and bright red dots under skin. The rash is seen first on the neck and upper part of chest, and lasts three to ten days, when it fades and the skin peels in scales, flakes, or even large pieces.	Discharges from nose and mouth, suppurating glands or ears of a patient. Milk may convey infection.	Yes	Yes	Yes	Yes	Yes
Smallpox	Onset sudden, usually with fever and severe backache. About third day upon subsidence of constitutional symptoms red shotlike pimples, felt below the skin, and seen first about the face and wrists most on exposed surfaces, develop. They form little blisters and after two days more become filled with yellowish matter. Scabs form which begin to fall off about the fourteenth day.	All discharges of a patient and particles of skin or scabs.	Yes	Yes	Yes	Yes	No
Sore Throat, Acute, Septic	Begins with sore throat and weakness. Throat diffusely reddened and may show patches like diphtheria.	Discharges from nose and mouth of a patient.	Yes	No	No	No	No
Whooping Cough	Begins with cough which is worse at night. Symptoms may at first be very mild. Characteristic "whooping" cough develops in about 2 weeks, and the spasm of coughing sometimes ends with vomiting.	Discharges from nose and mouth of a patient.	Yes	Yes	No	Yes	No

* Immunes are those who have had the diseases or in smallpox, who have been successfully vaccin-

Disinfection: The cleansing and disinfection of the person includes washing the entire body and

and douching and spraying the nose with an antiseptic solution; and finally, a complete change of clothing

these are put on again).

AMONG CHILDREN—*Continued*

Duration of Exclusion from Date of Onset					Remarks
Patient	Patient goes to hospital	Patient remains isolated at home		Children exposed at school	
	Other children of the same household	Other children who remain at home	Children who leave household as soon as disease is discovered		
Until patient is recovered. Disinfection of person; at least 21 days	14 days from time child last saw patient.	Until 14 days after quarantine has been raised.	14 days from time child last saw patient.		Disease is most communicable in the early stages. After effect is paralysis of certain muscle groups, transitory or permanent. Death is due usually to paralysis of respiratory muscles.
At least 30 days and until discharges have ceased and disinfection of person.	7 days from time child last saw patient.	Until 7 days after quarantine has been raised.	7 days from time child last saw patient.		Dangerous both during attack and from after effects. Great variation in type of disease. Slight attacks are as infectious as severe ones. Many mild cases not diagnosed and many concealed. A second attack is rare. When scarlet fever occurs in a school, all cases of sore throat should be sent home and health officer notified. Most fatal in children under 10 years.
Recovery and disinfection of person; at least 14 days.	Exclude if non-immune until 21st day after child last saw patient, or 7 days after successful vaccination and disinfection of person.	Exclude if non-immune until 20 days after quarantine has been raised or 7 days after successful vaccination and disinfection of person.	Exclude if non-immune until 21st day after child last saw patient, or 7 days after successful vaccination and disinfection of person.	Exclude 20 days unless they have been successfully vaccinated within 1 year in which case they may return at once.	Peculiarly infectious. When smallpox occurs in connection with a school or with any of the children's homes all persons exposed must be vaccinated or quarantined for a period of 20 days. Cases of modified smallpox in vaccinated persons, may be, and often are, so slight as to escape detection. Fact of existence of disease may be concealed. Mild or modified smallpox is as infectious as severe type.
Until recovery.					Often leads to serious results, affections of heart, kidneys, etc. Very apt to occur in epidemics due to milk contaminated by a patient suffering from the disease.
Eight weeks or until 1 week after last characteristic cough and disinfection of person.	Fourteen days provided no cough develops.				After effects often very severe and disease causes great debility. Relapses are apt to occur. Second attack rare. Specially infectious for first week or two. If a child vomits after a paroxysm of coughing, it is probably suffering from whooping cough. Great variation in type of disease. Often fatal in young children.

ated within a year.
the hair with soap and water; thorough brushing of the teeth; rinsing the mouth; gargling the throat, (or a change of underwear and a thorough shaking and brushing of the outer garments out of doors before

5 days, and the child exposed should be excluded at once. On the other hand, the period of incubation for measles is about 10 days and the exposed pupil should not be excluded from school till about a week after exposure.

The time at which a "contact" may be re-admitted to school depends upon the *maximum* length of the incubation period, assuming that he has not contracted the disease after being excluded. If the pupil has taken the disease after being excluded then the time for readmission depends upon the *period of communicability* of the particular disease.

It is important that a child who reveals symptoms of illness be excluded at once. Waiting till the pupil's case can be diagnosed may be disastrous to the school. It is better to exclude the pupil at once and let the diagnosis be made afterward.

Several of the "children's diseases" show early symptoms resembling those of incipient "colds." What appears to be a "cold" in the beginning should always arouse suspicion and is ample justification for exclusion. Even though it may be only a "cold," it is most infectious in the early stages and justifies exclusion on that account alone. Some schools have organized "Stay at Home with Colds" campaigns. Parents are to be encouraged to keep pupils at home on the slightest indications of illness.

Furthermore, parents should be encouraged to immunize their children against smallpox, scarlet fever, diphtheria, and typhoid. Typhoid is mentioned here because the school ought to encourage preventive science, and not because of great likelihood of an epidemic of typhoid occurring in the school if a student develops a case, although such an epidemic could develop from a case in a school of low sanitary conditions.

The two groups of diseases which most concern the teacher and school authorities are those disseminated by alvine discharges and by droplets of the nose and mouth. The last named is the more important group of the two. Which diseases of those disseminated by droplets concern the school specially?

The Classroom Immunity Chart accompanying may very profitably be copied, filled in and kept in the desks of the teachers and in that of the principal or superintendent. The immunity chart may prove of great use in case of an outbreak of communicable disease in the school. It would furnish valuable information needed in control of the outbreak.

An excellent little book on the control of communicable diseases in the school is that of Wood and Rowell, "Health through Prevention and Control of Diseases," published by World Book Co., Yonkers-on-Hudson, N. Y.

CLASSROOM IMMUNITY CHART

Modified from Wood and Rowell's "Health through Prevention and Control of Diseases,"
Copyright 1925 by World Book Co., Yonkers-on-Hudson, N. Y.

Year______ School________________ Grade______ Teacher________________

Pupil	Age	Contagious Diseases had by Pupil and Years								Immunization				Other children of family—grades and names of schools
		Chicken Pox	Diph-theria	German Measles	Measles	Mumps	Scarlet Fever	Small-pox	Whoop-ing Cough	Diph-theria	Scarlet Fever	Small-pox	Typhoid	
Smith, John		'21			'24	?				'21				Mary—V—Mck. Henry—III—Jef.

IV. OPERATION OF THE HYGIENE OF THE SCHOOL PLANT

Toilets and Privies.—If no water-carriage system is had in connection with the toilets or privies, a sanitary method of disposal is still not impossible. The pit privy, disposal by cesspool or septic tank or by chemical closet are approved methods named in ascending order of desirability. These methods of disposal have been described in Chapter II and the student should here review those sections of that chapter describing them. Needless to say, toilets should be kept as clean as possible and no obscene writings or drawings tolerated. Pupils should not be allowed to loiter within or near the toilet. Sanitary toilets are of esthetic value, of course, but the chief purpose for insisting on their being sanitary is the prevention of the bowel-disseminated infections, especially typhoid, paratyphoid, dysentery and hookworm.

The Water Supply, Drinking Fountains, Lavatories.—The water supply must be of unquestioned sanitary value, for prevention of the bowel-disseminated diseases. In case the water of the school is not derived from a carefully guarded public water system, a well may be constructed according to methods described in Chapter II. It is of utmost importance that the water entering the well be made to filter down through some 30 feet of earth without crevices before entering the well. Therefore, the wall of the well should be water-tight and the top cover water-proof. Bacteriological analyses are useful, but it is more important that the water be guarded by careful sanitary construction. Analysis merely tells what contamination has already occurred, and it may reveal that information too late. Proper construction and clean surroundings are more important.

Even in the country school simple and cheap home-made drinking fountains may be provided. But in lifting the water to any reservoir or tank before it goes to the fountain there must be no chance for contamination with hands or otherwise. The water should be pumped from the well to such reservoir. No " priming " of the pump is allowable. Why? Lavatories should be provided where the children, especially before the noon lunch, may wash hands. Perhaps the time will soon arrive when each schoolroom will be provided with a lavatory, soap and paper towels. But children should wash under running water, not in stoppered basins. The stoppers of such wash basins would better be discarded.

Adjustment of Seats and Desks.—Both seats and desks of a schoolroom should be of a type adjustable to the heights and needs of the pupils. The desk may be adjusted so that it is neither too high nor too low. If too low, it encourages bad posture and strain of eyes. If too

high, the writing arm of the student may be raised to such degree that lateral curvature of the spine slowly occurs as the months pass. Curvature of the spine is a much more frequent defect than most persons may suppose, as is to be seen by the teacher if the clothing of pupils is stripped to the waists.

It is important also that the seats be adjusted to proper height for each pupil. Dangling of the feet above the floor results in a decreased blood flow to the feet, due to pressure of the seat's front edge upon the area back of the knees. The artery passing to the foot is very superficial behind the knee and easily closed partially. Retardation of blood flow to and from the feet in some way causes thickening and congesting of the membranes of the nasal passages which results in sneezing and a " running " nose. It is believed that high seats are responsible for a considerable percentage of " colds " occurring in schoolrooms. But aside from the " colds " consideration, high seats make uncomfortable pupils who are retarded in the learning process because of the discomfort.

Lighting the Schoolroom.—In the construction of school buildings it should be so arranged that all the rooms, if possible, have a north light. The west light is probably next most desired after the north, for in most schools the pupils do not remain in the afternoon until the sun is far inclined in the west.

Rooms should be lighted from only one side. The seats should be so placed that the pupils have the lighted side at their left, since most students write with their right hands. Under such arrangement most pupils will not have cross-shadows on their papers while writing.

Windows should fill all the one side of the room, as nearly as construction will allow. The tops of the windows should reach to within a few inches of the ceiling, especially in warmer climates where the warmer upper air in the room may find exit when the upper sash of the window is lowered. The bottoms of windows should be high enough above the floor so that the lower ends of the windows are well above the heads of the children while seated. Why?

The window shades should be of the type which consists of two rolls attached midway between the top and bottom of the windows, one roll capable of being drawn toward the top and the other toward the bottom. Perhaps buff is the most desirable color for window shades.

Buff or light green walls are regarded as most restful to the eye. Blackboards should be fairly dark green.

Ventilating and Heating the Schoolroom.—In Chapter III we considered rather extendedly the principles of ventilation and heating.

That portion of Chapter III should be read again by the student at this point.

A summary statement may be made of heating and ventilation as they apply specially to the schoolroom: It has been shown that pupils study best and most effectively at a temperature of 66° to 68° F. and that they experience fewer cases of " colds " within that range than at higher or lower ranges; that pupils in window-gravity-exhaust ventilated rooms (described in Chapter III) reveal fewer cases of " colds " than pupils in fan-ventilated rooms; that window-gravity-exhaust method of ventilation is insufficient for rooms seating more than 100 persons, such as school assembly rooms.

The placing of the thermometer in a schoolroom is an item of far greater importance than most of us have thought. We all have, of course, given consideration to the placing of the thermometer with reference to the stove or radiator. But fewer teachers have given thought to the instrument with reference to height from the floor. The author has found a difference of about 12° F. in the temperature near the floor and near the ceiling of the schoolroom. Other investigators have noted similar wide variations. It then becomes an important question as to how high above the floor the thermometer should be placed. Perhaps it should be hung at about the level of the seats or waistlines of the pupils. It is advisable that more than one thermometer be placed in each room. Thermometers vary in accuracy.

The problems of heating and ventilating are especially closely related to the incidence of the respiratory diseases, as mentioned previously; although, of course, heating and ventilation have other health relations besides those connected with respiratory disease.

V. HEALTH SERVICE FOR THE PUPIL

Importance of Health Service.—This is one of the most important phases of the school health program. It consists of the examination of school children for physical and nutritional defects and the correction of them by physicians and dentists. In some cities the medical men are employees of the boards of education; in others, they are members of the city health departments. The first-mentioned arrangement is regarded as preferable. Examinations of many thousands of school children have been made in many cities and rural communities in various portions of the United States. Taking the average of these findings, we learn that the conditions prevailing throughout the country are about as follows:

Defects	Percentage of Children Showing the Defect,
Defective teeth	40
Enlarged or infected tonsils	22
Enlarged adenoids	17
Eye defects	16
Malnutrition	12
Enlarged glands of neck	4
Defective ears	3
Breathing defects	3
Spinal curvature	2.5

The table above reveals to us the surprisingly large percentage of school children who are defective. To induce negligent or ignorant parents to have corrections of such physical and nutritional defects made is a highly important matter in the lives of such children. In many instances the success or failure of a life depends on whether such corrections be made.

Health Service in the Most Advanced School Systems.—A very useful book which has recently appeared is that of Wood and Rowell, "Health Inspection and Medical Supervision of Schools," W. B. Saunders Co.

In the communities which have made most advances in health training, chiefly in the large cities, school physicians and school nurses and dentists are employed for full-time work. Rooms are provided and equipped in each building for such workers.

Duties of the School Physician.—The physician makes at least one thorough examination of each student yearly, and examines individual pupils again during the year as occasion may demand. He writes recommendations to parents regarding needed corrections of defects and suggests that the children should be attended by the family physician. In some school systems the school physician himself makes corrections, with consent of parents. It is the physician's duty to examine a child who shows symptoms of illness, when such case is brought to his attention by the nurse or teacher. If deemed necessary he excludes the child from school. The physician thus may prevent epidemics in school.

Experience has shown that a physician may properly serve about 2500 pupils.

Duties of the Nurse.—The nurse is under the direction of the physician and dentist. She visits each school daily, while the doctor and dentist may not. She examines pupils whom the teacher suspects of being ill, and may exclude. The nurse also visits the homes of chil-

dren after the parents have received notes from the physician or dentist suggesting correction of defects. In her visits the nurse tactfully

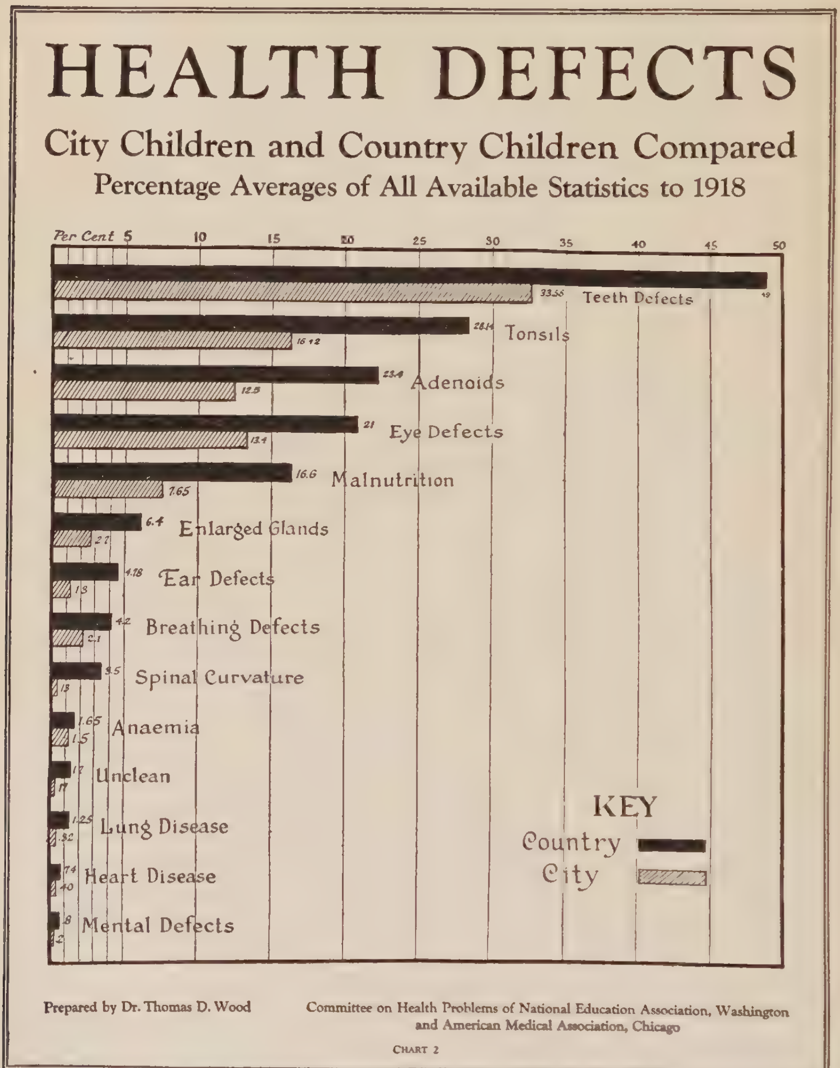


FIG. 62.—The energetic rural teacher can change this picture. (By courtesy of Dr. Thomas D. Wood, Teachers College, Columbia University.)

obtains a volunteer promise of parents to see that the corrections are made. This "follow-up" work of the nurse is of great importance.

The recommendation alone of the physician or dentist obtains, on the average, correction of about 20 per cent of defects. With the aid of the

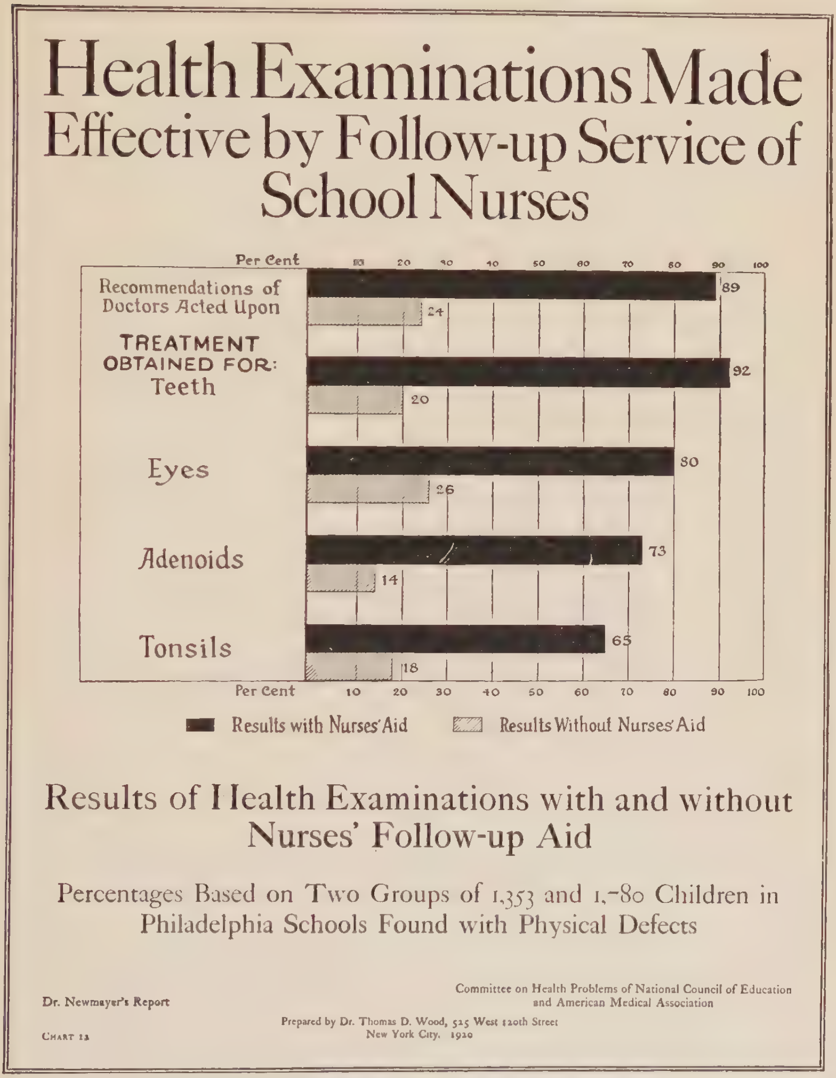


FIG. 63.—If no nurse is employed the teacher may substitute. (By courtesy of Dr. Thomas D. Wood, Teachers College, Columbia University.)

nurse's "follow-up" visits an average of about 80 per cent of defects are corrected (Fig. 63).

The nurse may properly care for something like 2500 pupils, assuming that she has the aid of a physician and a dentist (Fig. 64).

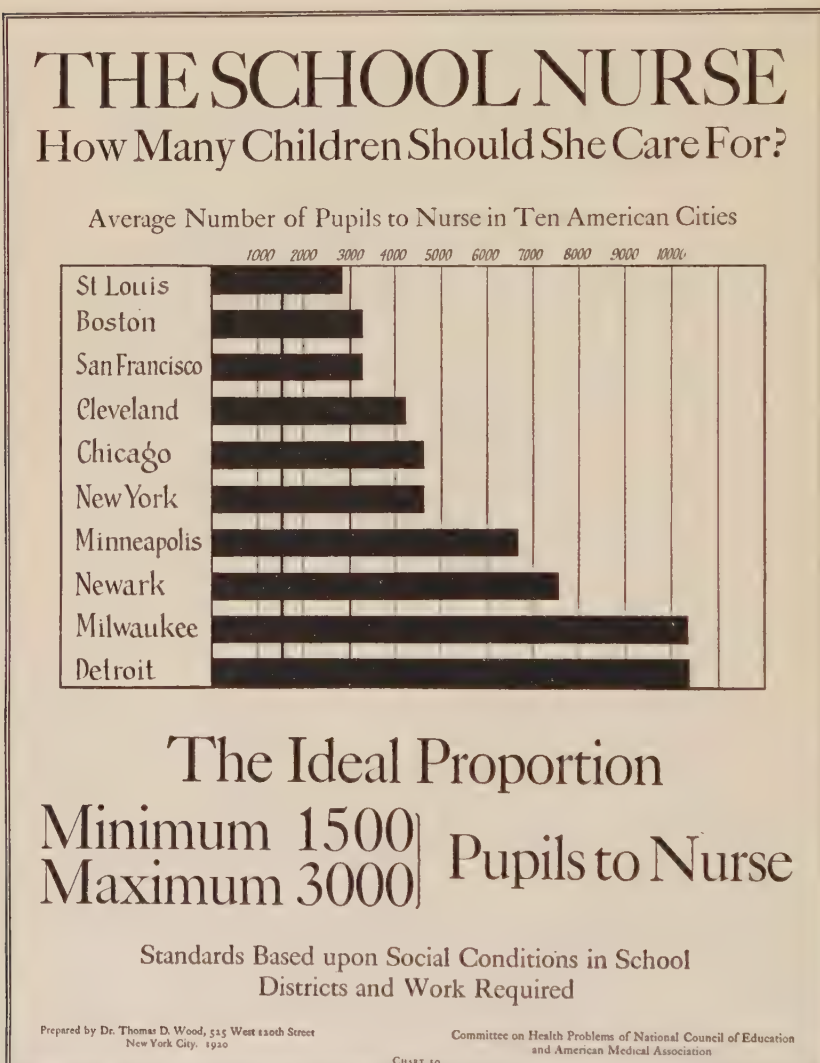


Fig. 64.—Appropriate number of school children per nurse. (By courtesy of Dr. Thomas D. Wood, Teachers College, Columbia University.)

Duties of the School Dentist.—The dentist usually makes examination of each child each year. In some communities the dentist merely

recommends corrections to parents, those corrections to be made by the family's dentist. In other school systems he himself makes the corrections. In still other communities he corrects and repairs only for those children whose parents are too poor to pay for service.

The dentist may have an assistant, a dental hygienist, whose duty is to aid in examining the teeth of children, make record of their condition, and to instruct the children in brushing the teeth and the care of the mouth.

As an example of the organization and personnel of the dental health service rendered in some of the larger city school systems, we may mention that of Cleveland, Ohio. The following quotation will suffice.

> Twenty-two dentists spend their time with 6-year old children (doing repair work); 17 dental hygienists teach the children from kindergarten to the sixth grade to use a toothbrush and how to use it, and also encourage the use of milk, green leafy vegetables, fresh fruits, and other vegetables as a proper diet; 22 mouth hygiene assistants act as clerks and helpers for the dentists and hygienists; 2 dentists and 3 assistants annually examine 85,000 to 90,000 children; 2 secretaries care for the office routine, of records, etc., and the remaining 1 person tries to keep the staff working happily and efficiently.

The Cleveland staff does no dental repair work, except in the first year in which the child is in school. It will be seen from the quotation above that most of the 69 persons engaged in the dental service are engaged in various phases of prevention and dental hygiene teaching, which perhaps is more important than repair work. The Cleveland staff does no dental work in 25 schools of well-to-do sections of the city.

Health Service in Smaller Schools and Systems.—In small communities where not so much money is derived from taxation the physician, dentist and nurse may be employed for only part time. In such communities the teachers may be depended upon to do the " follow-up."

If the community is unable to employ a physician, dentist and nurse, even for part tine, and must limit its number of medical employees, it is preferable that of the three the nurse be retained. Nurses' salaries are less than those of physicians and dentists, and yet they are able to accomplish a great deal. They may examine children for conspicuous physical defects, and make recommendations to parents. Teachers may aid in the " follow-up " work. Or services of physicians and dentists for making examinations may be obtained for a few half-days per year, free of charge, which most professional men of those orders gladly render. Women's church organizations or other charitable associations may pay for correction of defects in children of the poor.

The Part of the Teacher in the Small School.—There are many small schools in which even the services of a nurse are not had. In such schools the teachers themselves may train for recognition of the most conspicuous and outstanding defects. It has been found that where teachers make a little effort at training that they are enabled to detect about 80 per cent of the physical defects which need correction.

Defects which teachers should be able to recognize in conspicuous forms are the following: near-sight, far-sight and trachoma of the eyes; deafness and "running" ears; enlarged or infected tonsils; enlarged adenoids or other pronounced obstructions in the breathing passages; decayed or irregularly aligned teeth; ulcers and pyorrhea of gums; and malnutrition. Directions for making such examinations of pupils are given in Part IV of this book. Any physician or dentist of the community will gladly make suggestions to teachers, or might even give demonstrations in his office. After the teacher has examined several tonsils, for instance, she comes to know how the average tonsil appears and will readily recognize most of the pronounced defects.

But the teacher must avoid making a definite diagnosis. It is better that she express her opinion not too definitely and positively, for her diagnosis, if one is made, may be contradicted when the child goes to the medical man. Before beginning examination of children it is well for the teacher to speak to the medical men of the community, saying that she hopes to detect the more conspicuous defects in her pupils and that she hopes to get the children sent to them, the doctors, for final diagnosis.

In counties which maintain full county health units the county health officer and his public health nurse may be secured for making examinations of the children.

In making corrections the physicians and dentists of the community probably will give their services free of charge to cases which are really indigent. It is well also that the teacher remember that a much larger percentage of corrections, perhaps four times as many, is attained when tactful "follow-up" visits are made to the homes.

One of the most important and highly useful services which any teacher may render is that of regularly weighing the children, finding out those who are malnourished, determining the cause of the malnutrition and tactfully obtaining the correction of the condition.

Starting the Health Program in the Small School.—We have mentioned that there are five health activities of the school which compose the complete school health program. How should one start to establish

a health program in a small school? Briefly, we may state the course to be pursued.

Organize a parent-teacher association, if one is not already in existence. In the first two or three monthly meetings of the association take 10 minutes to outline the projected school health program and what is to be done. Outline the project by installments, one installment in each of the 10-minute periods mentioned. Describe the five things to be done.

During the two or three months' period mentioned above the health instruction and health habits formation phases of the program may be started. Scientific operation of the hygiene of the school plant will be in progress, and a readiness will be maintained for control of any outbreak of communicable disease.

Health service for the pupils perhaps can best be organized by tactful members of the parent-teacher association rather than by a teacher. Such members may speak to the doctors and dentists available and obtain their services, free of charge, for examining the pupils. If no physician or dentist or nurse is available the teacher is to examine the pupils. The teacher's may be known as a *health* examination in contradistinction to the *medical* examination of the physician. Of course, the medical examination is far more to be desired, when available.

To obtain a high percentage of corrections to be made, the parent-teacher association may be highly useful. During the two or three months' period since the launching of the movement the members of the association will be speaking to their neighbors, and thus a large percentage of parents will be prepared. After the examinations are made and defects recorded (cards for such records may be had from the American Red Cross, Washington, D. C.) and notices of defects sent to parents, the teachers or perhaps members of the parent-teacher association may call at the homes and tactfully endeavor to lead parents into a promise to have defects corrected by the family physician or dentist. The parent-teacher association may be very profitably used in creating a favorable sentiment. *A frequent cause of reduced results, as compared with expectations, is the failure to enlist the sympathy and support of parents.*

The departments of education in some states now maintain expert aid in health training and such experts may be obtained, without charge, to help in the organization of the school health program.

VI. SEX EDUCATION IN THE SCHOOLS

A troublesome special topic for most teachers is that of sex education. The proper place for such instruction is the home, yet few parents are prepared to teach their sons or daughters the scientific facts concerning the origin of life and few are disposed to attempt it. The home appears to be leaving that topic of instruction to the school, just as in recent years it has delegated other home functions and duties to the school. The more intelligent parents are expecting their sons and daughters to acquire correct scientific ideas regarding reproduction and sex hygiene from their courses in the biological sciences, especially in the high school.

Sex Education in the Grades.—Reproduction may be taught in the grades directly and sex hygiene indirectly. But the reproduction to be taught in the grades deals with those methods of reproduction found in the *plant* kingdom, *not* with human reproduction. The nature study hour is the proper time and place for this instruction. The well-trained and thoughtful teacher by means of more or less casual remarks along the way inspires a natural and unaffected reverence in the minds of pupils for the Creator's ways of providing for the perpetuation of his children, the plants. But it is distinctly understood that the teacher is not to adopt the sentimental, long-faced pious attitude which frequently pervades weakly efforts at teaching reproduction and which invariably fall short of their purpose.

Reproduction and Sex Hygiene in the High School.—Education in matters of sex in the human being must begin in the junior high school or, preferably, in the upper grades. Investigations have revealed that the great majority of boys receive their first permanent impressions of sex before they reach the age of twelve. Usually such impressions were crude and erroneous. Correct teaching with regard to sex should reach the pupil before his twelfth year.

Classes in the Biological Sciences the Place.—Reproduction can best be taught in the physiology, general biology, botany or zoology class. The subject should be introduced toward the end of the course, when the pupils shall have acquired a more or less scientific attitude of mind. In general biology, for instance, the student will have become accustomed to thinking in terms of reproduction among plants and animals and will be the better equipped to consider human reproduction in a scientific attitude of mind. To say the least, he can more nearly think of it as an abstract, impersonal scientific subject.

Boys and girls are to be taught in segregated classes. Men teachers are to teach the boys and women teachers the girls.

Language and Mental Attitudes.—Plain, clear language is to be used, without too much scientific terminology. Evasive language is to be avoided. A natural voice and manner are to prevail. Sex facts are to be taught as purely scientific facts. Attention may be called to the Creator's remarkable provisions for the perpetuation of his creatures, but no sickly, sentimental, affected piety is to be tolerated. The pupil will invariably detect it, a conscious or unconscious disgust is aroused, and one of the primary objects of the teaching has fallen flat.

Topics to Be Taught.—Suitable topics may be named: structure, physiology and hygiene of the internal sex organs; laws of heredity; continence; mental hygiene in relation to sex; the meaning of marriage; venereal diseases, advertising quacks, "patent" remedies and the unscrupulous druggists who sell such remedies instead of advising the patient to seek the best medical attention immediately. Additional topics for boys' classes are nightly emissions and masturbation. Menstruation and its hygiene is an additional topic for girls. The subject matter may be somewhat similar to that in Chapters VI and X of this book.

The Teacher.—Success or failure to attain the objects of sex education depends wholly on the training and personality of the teacher.

(1) The teacher must be a person for whom the students possess a high degree of respect.

(2) The teacher must be well trained in biology, in order to present the scientific topics named above. A teacher lacking this factor should not attempt the task.

(3) The teacher furthermore must be one who can present the facts relating to sex in a purely abstract, scientific attitude of mind, without self-consciousness. The teacher of biology, who is accustomed to instructing in matters relating to reproduction in plant and animal forms, is usually the best prepared in scientific subject matter and in attitude of mind.

All too frequently the sex instruction is left to the high school physical training teacher, the average of whom is in possession of neither the second nor the third of the three factors named above.

VII. SCIENTIFIC PREPARATION OF THE TEACHER

The minimum preparation of the teacher for the health training phase of her school work will embrace something similar to the following:

(1) *Chemistry.*—One college course in chemistry is very essential to a full appreciation of certain phases of the health work, especially that of foods and nutrition, which is of greatest importance.

(2) *General Biology.*—Instead of one course in general biology, one each in college Botany and Zoology may be substituted.

(3) *Physiology (and Anatomy)*—One elementary college course.

(4) *Elementary Bacteriology.*—Certain of the most important phases of hygiene and sanitation so largely consist of applied bacteriology that a short course in that science is highly desirable.

(5) *Hygiene and Sanitation*—One college course is sufficient.

(6) *Physical Training*—One year as a minimum.

Excepting the chemistry and physical training mentioned, all the above-named courses may be replaced by a single composite course such as that outlined in this text-book. It would prescribe all the laboratory and field work and personal hygiene projects included in Part IV. Yet, it is recognized that this proposed substitute is really too low a minimum preparation of the teacher for what should be the most fundamental single problem of the school. All of the six college courses mentioned above compose a more desirable minimal preparation.

An additional highly desirable course is that of Foods and Nutrition. It certainly should enter into the prospective teacher's plan of training unless special attention was given to foods and nutrition in the hygiene course mentioned above.

It should be unnecessary to say that the teacher must be robust in appearance and in health and above reproach in the matter of health habits. The teacher must be an example of good health.

PART IV

PROJECTS IN PERSONAL HEALTH AND LABORATORY AND FIELD EXERCISES

PROJECTS IN PERSONAL HEALTH AND LABORATORY AND FIELD EXERCISES

The subject matter of the following Exercises is arranged in the same general order as the subject matter of the text proper in Parts I, II and III. The Exercises will be done concu rently with the reading of the chapters which comprise the three Parts named above.

For the work of the laboratory, field and personal health projects each student will need the following named materials: 4 H drawing pencil; soft rubber eraser; loose-leaf notebook cover; ruled paper for loose-leaf notebook; drawing paper for the loose-leaf notebook, a smooth stiff paper.

All drawings will be handed in the same day on which they are done. The name of the student should be at the top of the sheet, right-hand corner.

Except the drawings, all notebook work will be done the night of the day on which the Exercise was done and the loose sheets handed in at the next class meeting. The student's name should be at the upper right-hand corner of each sheet.

The drawings and other notebook work will be looked over and marks of criticism inserted. The sheets will then be rubber stamped with the name of this department of the college. If the sheet be wholly unsatisfactory, it will not be rubber stamped. Sheets which do not bear the stamp will be re-written by the student and handed in at the next class meeting. All of the Exercises are to be written up in the notebook.

Formulas for making all stains, media, solutions, etc., may be found in Appendix B of this book.

EXERCISE 1. STUDY OF A MANY-CELLED PLANT

Materials Needed: A part of an onion; forceps; a microscope slide; a cover glass; iodine, diluted about 50 per cent with water; medicine dropper; and a microscope.

Procedure: Remove the dry outer portion of an onion. From one of the layers within take a piece of the "skin" about the size of a dime. With forceps put the skin into a drop of diluted iodine on a clean microscope slide. See that the skin is not folded upon itself. Cover with a clean cover glass.

Examination and Record: Examine first under low power of the microscope, then under high power.

It will be seen that the sheet of skin is composed of a layer consisting of many closely adjacent cells, the layer being only one cell in thickness. Each cell consists of the following named parts: **cell wall,** surrounding the cell contents; **cytoplasm,** which is the more or less transparent and homogeneous mass within the cell wall and adjacent to it; the **nucleus,** a spherical dense body, darkly stained by the iodine and surrounded by the cytoplasm. The nucleus may be near the center of the cytoplasm and cell or it may be near one of the walls. Within the nucleus may be seen one or two **nucleoli,** tiny dots so densely stained that they appear black. The nucleoli can be seen only with the high-power magnification. The nucleus and cytoplasm together compose the **protoplasm** or living matter.

Sketch three or four adjoining cells, as seen under the high power. The drawing of a single cell should be something like the size of the last joint of the finger. The drawings of the cells should be carefully shaped, exactly as they appear in the microscope. Frequently look into the microscope while making the drawing. Label all parts of one of the cells, labeling those parts of the cell named above.

An entire onion consists of how many cells, do you suppose?

EXERCISE 2. A ONE-CELLED PLANT

Materials Needed: *Pleurococcus* (*Protococcus*) or some other one-celled alga; medicine dropper; microscope slide; cover glass.

Procedure: *Pleurococcus* or some other one-celled plant will be furnished. These single-celled plants belong to a group of plants called Algae and may be found growing on the sides of trees, posts, or walls, especially in wet seasons of the spring or summer. They give the appearance of being green paint. Some single-celled organisms may be found in the green scum on the surface of a pool of water or on the surface of a sluggish stream.

Scrape off a little of the material furnished into a very small drop of water on a clean slide. Cover with cover glass.

Examination and Record: Examine under both low power and high power of the microscope. Under the high power note that there are no walls dividing the plant into cells. Its body consists of only one cell. Look for a plant which has just divided to form two plants. **Sketch** two or three of these little plants. **Sketch** one which is just dividing in the process of multiplication. Make these drawings as large as a dime or larger.

All one-celled plant and animal organisms multiply by dividing.

EXERCISE 3. LIVING BACTERIA

Materials Needed: Hay infusion 24 to 48 hours old; slide and cover glass; medicine dropper.

Procedure: A hay infusion will be made by putting a small handful of hay or dried grass collected from a field or pasture into a jar of water. After the jar has set in a warm place for 1 or 2 days, put a bit of the scum from the surface of the water on a slide and cover with cover glass.

Examination and Record: Examine under low power, then high. Tiny transparent specks will be seen. They may possess a flitting or shimmering motion or there may be no motion perceptible. While looking for them, adjust the diaphragm of the microscope so as to obtain a low degree of light, for bacteria can best be seen with a low degree. Bacteria do not have green coloring matter in their bodies, as did the algae. Note also that they are much smaller than algae. They are of different shapes or form, some being spherical, others rod-shaped, and still others are spiral like a corkscrew. Some or all of these forms may be seen. **Sketch** about three of the bacteria, preferably of different forms. Make the drawings much larger than they appear in the microscope.

EXERCISE 4. TO SHOW SPORES IN BACILLUS SUBTILIS

Materials Needed: Slide; methylene blue stain; inoculating loop (also called transfer loop); pure culture of *Bacillus subtilis* which is 3 to 5 days old (younger cultures do not contain spores); Bunsen burner.

Procedure: With inoculating loop take a small bit of culture from the test tube. Put the loopful of bacilli into a small drop of water on a slide, putting in just enough of the culture to give the drop of water a very slightly milky appearance. You are likely to get too much of the culture in the water. Put the loop in the flame of a Bunsen burner until red hot. While the loop is still hot spread the drop of water with the loop until the drop is about the size of a nickel. Carefully dry the slide over a flame, with a finger alongside the slide as a precaution against getting the slide so warm that the bacteria may burn. When perfectly dry put 5 drops of methylene blue stain on the smear of bacteria for 30 seconds to 1 minute. Wash the stain off under a very slowly running hydrant, holding the slide near to the mouth of the hydrant. Remove all surplus water by slinging the slide in hand. Dry carefully over the flame.

Examination and Record: Examine under oil immersion objective of the microscope. If no oil immersion objective is available high power may be used. Note the spores in the bacilli. The spores are tiny glassy spheres within the bacilli about the middle of them. The spores are unstained while the rest of the bacilli are stained. This stain will not penetrate the spore walls. It will be noted that the bacilli are in chains. **Sketch** three or four bacilli containing spores.

EXERCISE 5. STAINING OF BACTERIA FROM A HAY INFUSION

Materials Needed: Hay infusion 24 to 48 hours old; slide; methylene blue stain; Bunsen burner.

Procedure: Put a little of the scum from a hay infusion on a slide. Spread over a surface about the size of a nickel, using a red-hot loop for spreading. Dry the film by passing the slide very slightly over a flame, with a finger alongside the slide as a precaution against getting the slide too warm. When perfectly dry, put 5 drops of methylene blue on the film or smear. Let stain remain for 30 seconds to 1 minute. Wash off the stain under a slowly running hydrant. Dry the slide by first slinging drops of water from it, then by passing carefully over a flame.

Examination and Record: Examine with high power or preferably with oil immersion objective of a microscope. The latter named objective magnifies much more than does the high dry power. **Sketch** three or four different shapes and sizes of bacteria seen. The drawings should be much larger than the bacteria in the microscope appear.

EXERCISE 6. A MANY-CELLED ANIMAL

Materials Needed: A prepared slide showing a stained section of the liver of some animal.

Procedure: A *prepared* microscope slide will be furnished the student. This prepared slide contains a very thin slice or section cut through the liver of an animal. The section is stained so that the liver tissue does not appear in its natural color.

Examination and Record: Examine under low power. Note the large number of cells of which the section consists. Use high power. Note the parts of the cell—the cell wall or cell membrane, the cytoplasm, and the nucleus. In some cells there may be two or more nuclei. **Draw** two or three adjacent cells and label the parts of one of the cells, as was done in the case of the onion. In the drawing, each cell should be about the size of a nickel, but, of course, not of the same shape. The liver alone

of an animal consists of innumerable cells. How many cells in the human body, do you suppose?

EXERCISE 7. A ONE-CELLED ANIMAL ORGANISM (PROTOZOA)

Materials Needed: A hay infusion 3 to 5 days old; slide and cover glass; a little cotton.

Procedure: After a hay infusion has stood in a warm, light place from 3 to 5 days, examine the scum under the microscope.

Examination and Record: Large numbers of one-celled animal organisms may be seen, moving very swiftly, apparently. There may be several kinds of such animal organisms present. Notice that their bodies are not divided into cells. Their bodies consist of single cells. Some may be found which are in the process of dividing. One-celled animal organisms are called **protozoa**. **Sketch** two or three different kinds of protozoa. If they move about too rapidly to be sketched, put six or eight fibers of cotton under the cover glass to entangle them.

EXERCISE 8. TO DEMONSTRATE PUTREFACTION AND TO STUDY ITS CAUSE

Materials Needed: Raw meat cut up into very small pieces; 3 test tubes for each student; a little butter and flour.

Procedure: Pour about an inch of water into each of three test tubes. Into one tube put a small piece of meat; into another, about two pinches of flour; and into the third, pour 6 to 8 drops of melted butter. Leave all three tubes in an incubator or warm place for 2 or 3 days, or more.

Examination and Record: After 2 days or more observe the tubes. Note the odors. Which material putrefied? What caused the material to decompose? Why did only that one material decompose? Was it because of any preference of bacteria for that class of food? Flour is chiefly starch, meat is chiefly protein, and butter is a fat. Which of these three classes of food do bacteria usually prefer?

EXERCISE 9. TO SHOW THE EFFECT OF MOISTURE ON THE GROWTH OF BACTERIA AND ON THEIR ACTIVITIES

Materials Needed: Raw meat cut into small pieces; dried beans or peas; 4 test tubes for each student.

Procedure: Each student will be given 4 test tubes which are dry. Into one put a small piece of raw meat. Into a second put a small piece of raw meat and an inch of water. Into the third tube put two or three dried beans or peas. Into the fourth put an inch of water and two or three dried beans or peas. Set all four tubes in the incubator or in a warm place for 2 to 5 days.

Examination and Record: After 2 to 5 days compare the two tubes of meat with each other. Note their odors. Which has putrefied? Why did the one putrefy and the other not? Were bacteria able to live in the one and not in the other? Compare the two tubes of beans or peas in the same manner.

EXERCISE 10. TO SHOW THE EFFECT OF TEMPERATURE ON GROWTH OF BACTERIA AND ON THEIR ACTIVITIES

Materials Needed: Raw meat cut into small pieces; 3 test tubes.

Procedure: Put one small piece of raw meat in each of three test tubes. Pour an inch of water into each tube. Put one tube in the icebox, one in the incubator or

in a warm place, and leave the third in room temperature. Leave the tubes in these temperatures for 2 to 5 days.

Examination and Record: After 2 to 5 days note the odor and comparative amount of decomposition which have taken place in the tubes. In which is there most putrefaction and in which is there least? How do you account for this? Did the temperature of the icebox kill the bacteria which were in the test tube therein placed? Or did the temperature of the icebox merely prevent the multiplication and decomposing activity of the bacteria? To learn the answers of the last two questions, put the tube from the icebox into incubator 2 to 5 days.

EXERCISE 11. STERILIZING BY MEANS OF HEAT

Materials Needed: Two test tubes; raw meat cut into small pieces; cotton for plugging tubes; a beaker; a wire gauze; a tripod; a Bunsen burner.

Procedure: Each student will be given 2 test tubes. Fill each tube about one-third full with water. Into each tube put one or two small pieces of raw meat. Put cotton plugs in each tube. Heat one of the tubes by keeping in a boiling water bath for 20 minutes. (The water bath may be made by filling a beaker half full of water; the tube may be set in the beaker and boiled.) Leave both tubes in room temperature for 2 to 4 days.

Examination and Record: After 2 to 4 days note the odor in each tube. Which tube contains the putrefied meat? Why did it putrefy and why did the other not?

EXERCISE 12. OSMOSIS

Materials Needed: A half dozen eggs; the same number of pieces of small glass tubing each about 2 feet long; 6 small fruit jars, pint or quart sizes; 6 large-mouthed bottles, upon whose mouths the eggs may be set on ends; ring stands; sealing wax or paraffin; small iron bar.

Procedure: The students will be divided into small groups and each group will set up the experiment described below (Fig. 65). It is necessary that several experiments be set up, for probably some of the experiments will not result properly.

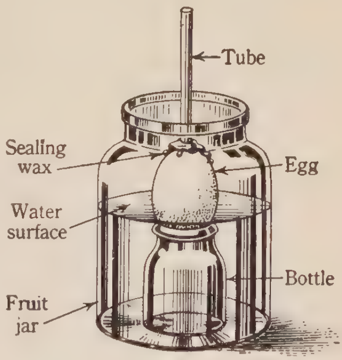


FIG. 65.—Apparatus to show Osmosis.

Select a large-mouthed bottle, or a staining jar, and set this bottle or jar into a small fruit jar. Fill the fruit jar and bottle within with water till the water stands about a half inch or more above the top of the bottle.

Carefully pick away the shell from the large end of an egg with a knife, without breaking the membrane beneath the shell. If the membrane is broken the egg will be useless for the experiment. The shell should be picked away from an area about the size of a dime. Now, break a small hole in the smaller end of the egg, through both shell and membrane, just large enough to admit a small glass tube. The tube should be about two feet long. Set the egg on the top of the bottle or staining jar, large end down. Push the glass tube down into the egg till the end of the tube is at

about the center of the egg. Support the tube with ring stand and clamp. With a hot iron bar and sealing wax (or paraffin) seal the opening at the upper end of the egg and around the tube so that it is made water-tight. Seal carefully. Leave for 24 hours.

Examination and Record: After several hours examine the experiments and note whether the egg white, or yellow, extends up into the tubes. Can you explain the force which holds the column up in the tube? The force is spoken of as **osmotic pressure.** Make record of results in notebook.

EXERCISE 13. STERILIZING BY MEANS OF DISINFECTANTS

Materials Needed: Four test tubes; white of egg; egg beater; bichloride of mercury solution (made by putting one gram bichloride of mercury into 1000 cc. of water and warming to dissolve); formalin, full strength; 2 per cent solution of carbolic acid (phenol).

Procedure: Mix white of egg with five times its quantity of water (hydrant water will not serve if it has been chlorinated). Stir with egg beater or other instrument until the egg and water are thoroughly mixed. Fill 4 test tubes one-third full of the mixture. Nothing is added to Tube 1. To Tube 2 add six drops of bichloride of mercury solution. Into Tube 3, three drops of formalin, full strength. Into Tube 4, ten drops of 2 per cent solution of carbolic acid. Record the appearance of the water in each tube, whether it is murky, etc. Put all tubes in room temperature about 3 to 5 days.

Examination and Record: After 3 to 5 days, examine. Determine which tubes show a bacterial growth by noting the odor of each tube and by examining to see if the water in the tube has become murky. Examine Tube 1 first and examine it again after the rest have been examined. Which tubes putrefied and which did not? State exactly how you account for the results. Look back over the quantities of disinfectants used and the strength of the solutions, then decide which disinfectant is strongest when in full strength and undiluted. Define *antiseptic* and *disinfectant.* Make record of results and answer questions.

EXERCISE 14. TO DEMONSTRATE BACTERIA FROM THE TEETH

Materials Needed: Microscope slide; cover glass; toothpicks; methylene blue stain; Bunsen burner.

Procedure: Put a very small drop of water on a slide. With the large end of a toothpick scrape about the bases of the teeth and between them. Rinse the toothpick off in the drop of water on the slide. Rinse it off carefully. Cover with cover glass.

Examination and Record: Examine under both low and high power. Were any bacteria found? A methylene blue stain might be made. Record findings.

EXERCISE 15. TO DEMONSTRATE BACTERIA IN THE MOUTH SPRAY

Materials Needed: Tube of agar; sterile Petri dish (or Petri plate); slide and cover glass; methylene blue stain; beaker; Bunsen burner.

Procedure: Put a tube of agar into a beaker of water and heat water to a boiling point until the agar is thoroughly melted. When you are sure that the agar is entirely melted, pour it into a sterile Petri dish (or Petri plate). Raise the top of the plate

just enough to pour the tube of agar beneath it. See that the agar covers the entire bottom of the plate by tilting about gently. When the agar has hardened thoroughly, cough vigorously with the open plate about 3 inches directly in front of the mouth. Cough strongly two or three times. Cover the plate. Invert it and put in incubator or warm place for 24 hours. It must be inverted while in the incubator.

Examination and Record: After 24 hours of incubation observe the plate. Note the white or yellowish colonies of bacteria. Examine a colony by transferring with a sterile loop a portion into a drop of water on the slide. Cover with cover glass, then examine under both low and high power. Or a methylene blue stain may be made. Was the colony really made up of large numbers of bacteria? What may be the result of sneezing or coughing without use of a handkerchief while in the presence of others? Do you think that the bacteria which cause " colds " could be transmitted by droplets from the nose or mouth? Are there causal agents of other diseases which could be transmitted in that manner? If so, of which diseases? Make record.

EXERCISE 16. TO DEMONSTRATE BACTERIA ON THE HANDS

Materials Needed: About 300 cc. of sterile water in a sterile dish, an agar tube, a sterile pipette, a sterile Petri dish, and a warm water bath made by putting water in container and heating over flame.

Procedure: Wash the hands in the sterile water contained in a sterile dish. With a sterile pipette transfer 1 cc. of the water to a sterile Petri dish, then cover the latter. Melt an agar tube in a boiling water bath, then cool down to about 43° C. and pour agar into the Petri dish containing the 1 cc. of water. Mix contents of Petri dish by tilting very carefully. Allow the agar to harden thoroughly, invert the plate and incubate in warm place or in incubator 24 or 48 hours.

Examination and Record: After incubation count the colonies of bacteria on the plate or dish. Each colony is probably derived from a single bacterium. Then how many bacteria were in the 1 cc. of water in which the hands were washed? From this estimate the total number of bacteria washed from the hands. Make record in notebook.

EXERCISE 17. TO DEMONSTRATE BACTERIA IN THE AIR

Materials Needed: Two agar tubes; two sterile Petri dishes; beaker; wire gauze.

Procedure: Melt two agar tubes in a water bath. When thoroughly melted, pour the agar into two sterile Petri dishes. See that the agar covers the bottoms of the plates well. Replace the covers. After the agar has solidified, expose one dish for 3 minutes to air of the laboratory by removing the top. Expose the other plate on the campus by setting it upon some object which will elevate it a few feet from the ground. Stand at one side of plate so that the wind will not blow dust from your clothing into the plate. Expose the plate for three minutes. Invert both plates and incubate 24 hours.

Examination and Record: After incubation of 24 hours or longer count the colonies of bacteria on each plate. Which contains most colonies of bacteria? How do you account for the difference in number? Calculate the number of bacteria falling per square foot per hour into each plate, assuming that each colony is derived from a single bacterium which fell into the plate.

EXERCISE 18. ASCARIS

Various species of this worm are found frequently infesting the intestines of children and of lower animals. Specimens of ascaris may be had in large numbers at a slaughter house. The soil becomes infested with eggs or embryos of the worms which pass with the feces from infested children or lower animals. Children acquire the worm by getting such infested soil into their mouths. **Sketch** a worm.

EXERCISE 19. TRICHINA (TRICHINELLA)

Specimens of this worm will be furnished in prepared slides which contain thin sections of infested pork. Examine the slides with low power of the microscope and then with high. The worms will be seen coiled up. **Sketch** one.

Man becomes infested with this worm by eating infested pork, not cooked sufficiently to kill the parasite.

EXERCISE 20. A TAPEWORM

Several specimens of tapeworm will be furnished the class. Note that the tapeworm consists of a series of joints or segments (called proglottids). The segments at the " head " end are smallest and youngest, those at the posterior end being the more mature ones. New segments are being formed continuously in the " neck " region while the more mature ones at the posterior end are being broken off. The mature segments which are broken off contain eggs, or embryos. There are several kinds or species of tapeworm which infest man. One species is gotten from fish, another from beef, another from the dog, etc.

Sketch a half dozen or more segments.

To avoid tapeworm, we avoid living in close association with lower animals, and eat meat which is cooked well done, not " rare."

EXERCISE 21. INSPECTION OF A SANITARY PRIVY

A sanitary privy, perhaps constructed or approved by the county health department, will be inspected. It may be a privy with a concrete or brick vault beneath; or it may be a " pit " privy, with a simple earth pit beneath; or it may be a privy with a septic tank; or one with a cesspool; or it may be a chemical closet.

Whichever type of privy may be inspected, describe its construction in detail. Make a **sketch** of a section through the privy from top to bottom as it would appear from the side. Label the parts.

Is the seat automatically covered when not in use?

Is the vault or pit, if any, fly-proof?

Does it appear likely that this privy might contaminate a nearby well or other source of water supply?

EXERCISE 22. INSPECTION OF THE LOCAL SEWAGE DISPOSAL PLANT

In your notebook write up the operation of the disposal plant.

Does your college town or city treat sewage or does it run the sewage untreated into a stream? If the latter, is the city violating any state law or federal law?

If an **Imhoff tank** is used in treatment of sewage, make a sketch of the plant and with arrows indicate the course of the sewage through the plant. How long is required for the sewage to pass through? Looking first at the influent then at the

effluent, does it appear that much of the solid matter in the sewage passes through with the effluent? What becomes of the solid matter? What is the ultimate fate of the solid matter? What group of bacteria are involved in the ultimate fate? Mention the bacteriological and chemical reactions taking place in the final fate of the solid matter. Make a cross-section sketch of this particular Imhoff tank as you think it is.

If an Imhoff tanks is used in the disposal of this sewage, is there a **trickling (sprinkling) filter** into which the effluent from the Imhoff tank is run? If so, explain the construction of the trickling filter bed and make a cross-section sketch of it as you think it is. Mention the bacteriological and chemical reactions occurring in the sprinkling filter. What group of bacteria are involved in these chemical reactions? Why is the sprinkling filter operated intermittently?

Is the effluent from the sprinkling filter chlorinated? If so, why?

If your college town or city makes use of an **activated sludge tank** for sewage disposal, observe the machinery used to pump the compressed air into the air chambers beneath the tanks. How deep are these tanks? How long is the sewage subjected to the oxygenating process? How long does it require the sewage to pass entirely through this plant? What special group of bacteria are active in the oxgenated sewage? Mention the chemical reactions taking place. Compare this group of bacteria and the chemical reactions with those concerned in the trickling filter. Are there also physico-chemical processes occurring which cause the solid matter to precipitate? What becomes of the sludge in this process? Do you think the sludge, containing nitrates, is useful for fertilizer? Is the effluent from this plant chlorinated?

If your city uses neither the Imhoff nor the activated sludge methods of sewage disposal, then describe in detail the method which is used.

EXERCISE 23. INSPECTION OF THE LOCAL WATER-PURIFICATION PLANT

Does the town or city in which your college is located purify the water supply? Or does any other agency purify the water?

What is the source of the water supply of the town or of the college—river, lake, wells, etc.?

Before the water is purified or treated, does it first pass through a sedimentation basin? If so, why?

Does the water pass through a coagulation or flocculation basin? If so, what chemical or chemicals are used to cause the flocculation or precipitation of the particles of sediment? Can you explain this chemical process?

Is the water filtered through sand beds? If so, is it a slow sand filter or is it a rapid sand (mechanical) filter?

If it is a rapid sand filter, ask to be shown a filter being " washed." Ask how deep the sand is in the filter bed? Does the sand have a layer of gravel or crushed rock beneath it? How often are the filters washed? What kind of water is used in the washing?

How many gallons per day are filtered?

Filtration accomplishes two purposes. What are they?

Is the water chlorinated? If so, for what purpose?

Describe the course of the water as it passes through the purification process or processes. Make a **sketch** to show its route or course through the plant.

EXERCISE 24. BACTERIOLOGICAL WATER ANALYSIS

Materials Needed: Two sterilized Petri dishes; two tubes of agar; a thermometer; a beaker; two Smith fermentation tubes filled with lactose (milk sugar) broth and sterilized, or instead of the Smith tubes two large test tubes containing small test tubes inverted and filled with the broth and sterilized; a sterilized flask filled with city water and a similar flask filled with creek or river water; 10-cc. pipettes in each flask of water.

Procedure: (1) *The Plate Count.* Put 1 cc. of city water into a sterilized Petri dish or plate and a like amount of river or creek water into another Petri dish. Keep the dishes covered. Melt two agar tubes in a water bath. After you are certain that all the agar is melted, cool the tubes in water bath down to 43° C. Pour the agar from the two tubes into the two Petri dishes containing the water. Tilt dishes about gently to mix water with agar before the latter hardens. Allow agar to harden. When certain that it is thoroughly hardened, invert the dishes and put into incubator at 37° C. for 24 hours.

(2) *The Bacillus Coli Test.*—Two large test tubes containing lactose (milk sugar) broth will be furnished you. Each test tube contains also a small test tube inverted and filled with the broth. The tubes and contents have been sterilized. Or two Smith fermentation tubes may be furnished instead. Put 10 cc. of city water into one tube. Into the other tube put a like amount of creek or river water. Set tubes in incubator 24 hours.

Examination and Record: (1) *The Plate Count.* After 24 hours of incubation, count the colonies of bacteria on the plates. Compare the number of colonies from the city water with the number from the creek or river water. How many colonies per cubic centimeter of each water? How do you account for the difference in the number from the two waters? Make record in tabular form.

Put a portion of one of the larger colonies into a drop of water on a slide. Cover with cover glass and examine under low and high power. Note that there are innumerable bacteria which probably are the progeny of a single bacterium from the water. Why can we make such statement with comparative safety?

(2) *The B. Coli Test.*—After 24 hours' incubation, observe. Is there gas formed in the upper part of the small inverted tubes, or in the closed arms of the Smith fermentation tubes, if the latter were used? If so, does the gas fill as much as one-tenth of the small tube or of the closed arm? If it does, it is an indication that *Bacillus coli* is present and that the water is polluted with intestinal discharges. What two diseases common in the United States *may* be gotten from drinking such water? Make record of findings in tabular form.

The bacteriological examination of water consists of two tests: (1) The **Plate Count** and (2) The **B. Coli Test.** The object of the plate count is to learn the relative number of bacteria in water. The object in making the B. coli test is to discover if there are intestinal discharges in the water. The germs of two important American diseases live in the intestines of diseased persons or "carriers." Hence if drinking water contains intestinal discharges there is great likelihood of contracting one or both of these diseases. We test for B. coli instead of for the specific germs of the two diseases because: (1) B. coli and those disease germs come from the same source, that is, the human intestines, and (2) B. coli is much easier detected than the two disease germs are.

EXERCISE 25. LIFE HISTORY OF THE HOUSE-FLY

A glass jar will be exhibited which contains the various stages in the development of the house-fly from egg stage to adult. (This exhibit is purchased from a biological supply house.) Study the various stages in the development of the house-fly and **sketch** each stage. Write a brief story of the life history of the fly. Mention diseases which the fly may disseminate and say how it may obtain the germs and how it may distribute them.

EXERCISE 26. THE HOOKWORM

Male and female hookworms will be furnished in prepared slides, which may be purchased from biological supply houses. Examine with low power of the microscope. The male has a broad fan-shaped " tail " while that of the female is pointed. **Sketch** both male and female. Write a short story of the life history of the hookworm. Perhaps the instructor will furnish a slide showing the larva in the infective stage. If he does, **draw** the larva.

EXERCISE 27. TABULAR OUTLINE OF THE INTESTINAL DISEASES

Each student will copy the following outline in his notebook and fill in the table with the facts relating to each of the diseases of the group disseminated by the intestinal discharges.

Name of Disease	Source of Causal Agent	Exit of Causal Agent	Entrance of Causal Agent	Agents of Transmission	Measures of Prevention

EXERCISE 28. SANITARY SURVEY OF A FARM HOME

Students will go in small groups to survey farm homes. In their notebooks they will copy the following outline and fill in with information of conditions found; then write up a brief summary of adverse conditions and make recommendations for the improvement of each item criticized.

Location of farm home:..

Signature of farmer or of his wife...

Names of the students making survey..

....

Date of survey.................. ....

Introduction: Description of general surroundings

Geology—kind of soil and subsoil
Topography and drainage

Water: Piped into farmhouse and barns

Well—depth, wall, cover, location with reference to barnyard, privy, cesspool, etc.
Cistern—kind and structure
Spring—provision for protection against contamination
Results of Bacillus coli test of the water

Sewage: Privy—open, screened, location, kind

Cesspool—condition, location
Septic tank

Milk: Conditions of place where milking is done

Evidence of care or lack of care in handling
Method of cooling
Appearance of cows, if seen, with reference to health
Cows tuberculin tested

Sanitary Nuisances: Odors—source

Distance of privy from house
Distance of barnyard from house
Pig pens, distance
Fowl roost, distance
Fowls in lawn or yard about house
Drainage from outhouses toward house

Residence: Screens—number of strands per inch—fit well—torn

Warm in cold weather
Leaks in roof
Ventilation
Porches for summer (if in South)
Heating—method
Conditions of crowding—number of persons, etc.

Mosquito Breeding Places:

Troughs
Flower pots
Drain from ice box
Roof gutters, sagging or clogged
Cistern, well, etc.
Leaking hydrant
Drain from bath or kitchen

Flies: Breeding places—manure, garbage, etc.

EXERCISE 29. SANITARY SURVEY OF A CITY RESIDENCE BLOCK

Students going in couples will make a sanitary survey of a residence block or blocks. More advantages will accrue to the student if he makes his survey in a poor section of the city. Copy the outline below in notebook and fill in the outline with information obtained as the survey is made. Also write up a general summary of conditions found in the community and make suggestions or recommendations for improvement.

The block surveyed is bounded by the following named streets: ....

....

Names of the two students making the survey: ....

Introduction: General Description of the Block

Topography:

Geology—kind of soil and subsoil and their depths
Population—number of families and the nationalities of the heads of families

Native white American
Negro
Italian
Other nationalities

Other information:

	Street: House No:	Street: House No:
Water—City supply or other source		
Sewage—by city system open privy other methods efficiency		
Milk—From city approved dairy privately owned cow pasteurized certified		
Nuisances—Odors and source Dust Stables and manure Irritating noises Pig pens		
Housing—Screens: condition, size of mesh Leaks in roof or wall Warm in cold weather Heating: method, sufficiency Ventilation Crowded		
Mosquito breeding places— Troughs Flower pots Roof gutters, sagging or clogged Tin cans Broken bottles Drain from bath Drain from ice box Leaking hydrant " Traps " of sinks, etc., not in use Tanks of unused closets or toilets Cisterns, etc.		
Flies—Breeding places: manure, garbage		
Other unsatisfactory conditions		

EXERCISE 30. A MOSQUITO FIELD TRIP

Materials Needed: Dippers with white inner surfaces; fruit jars, or other types of jars for collecting mosquito larvae, etc.

Procedure: This trip is made for the purpose of observing the eggs, larvae, and pupae, of the genuses of mosquitoes in their natural habitats, and for the further purpose of learning methods of discovering such forms.

It will be necessary for each couple of students to carry a cup or dipper with white inside surface with which to catch larvae and pupae. The inside white surface of the dipper makes any eggs or larvae contained therein easily seen and observed.

While on the trip, with the dipper dip up some of the water (without first disturbing the surface) of all artificial containers found. Make a visit to the pools and streams of the neighborhood and dip up some of the water from the edges of such pools and streams. The grassy edges of bodies of water are especially likely to reveal eggs and larvae. The Culex eggs are attached together in rafts of a hundred or two hundred eggs in a raft. Other mosquito eggs are laid singly, unattached, and are quite difficult to find. But the Culex rafts appear like particles of soot upon the surface of the water. Preserve any eggs, larvae and pupae thus found, in 4 per cent formaldehyde solution (full strength formaldehyde or formalin diluted 10 to 1 with water) for a future laboratory exercise. Some members of the class will keep their larvae and pupae in jars of water for the next exercise.

Write up the trip describing the kinds of places in which the eggs, larvae and pupae were found.

EXERCISE 31. IDENTIFICATION OF EGGS, LARVAE AND ADULT MOSQUITOES

Materials Needed: The eggs, larvae and pupae captured in the last exercise; adult mosquitoes, which should have been previously captured while flying about the screens outside a residence about dusk in the evening or early dawn in the morning. The adult mosquitoes may be captured by daubing with a handful of cotton fiber while the insects are trying to obtain entrance through the screens.

Pupae are difficult to identify as belonging to either of the genuses. It is better to rear pupae in a glass jar of water covered with cheesecloth, then identify them when they become adults. It may be noticed however by aid of a magnifying glass or low power of the microscope that there are two breathing tubes on the posterior side of the pupa's thorax.

Using a magnifying glass or a low power of the microscope, and by reference to the table below and to Fig. 26, identify the eggs, larvae and adult mosquitoes captured previously; that is, identify the genuses to which they belong. Or, instead of the materials mentioned above, the instructor may furnish the class with preserved specimens obtained from biological supply houses. Or again, he may have prepared slides containing the eggs and larvae of each of the three genuses and both male and female adults of each genus.

DISTINGUISHING CHARACTERS OF MOSQUITOES

Genuses	Culex	Aedes (Stegomyia)	Anopheles
Diseases transmitted.	Filariasis (Not important in United States).	Yellow fever and Dengue fever.	Malaria.
Kinds of breeding places and habits.	Artificial or natural collections of water — ponds, streams, cisterns, cans. Water may be filthy. Nocturnal.	Artificial collections only. Most domesticated of the genuses. Diurnal.	Natural collections —streams, ponds, etc. Clear water. Nocturnal.
Eggs.	Attached in rafts.	Separate.	Separate. Have floaters.
Larvae: Resting position; breathing tube or pore.	Oblique to surface of water. Has breathing tube.	Similar to Culex.	Parallel with water surface. Breathing pore only.
Adult: Position on resting surface.	Abdomen parallel with resting surface; humpbacked.	Similar to that of Culex.	Abdomen at angle, pointing outward from resting surface.
Palpi and antennae.	In female, palpi very short; antennae with short hairs. In male, palpi as long as proboscis; antennae with long hairs.	Similar to those of Culex.	In both sexes palpi at least as long as proboscis.
Color, wings, size.	Brownish, rather small.	Black with silver bands around legs; lyre-shaped figure on back. Small.	Brownish; spots on wings; rather large.

It will be noted in the table above that several characters of Aedes are similar to those of Culex. Those two genuses are very closely related, as they belong to the same family.

EXERCISE 32. A SURVEY OF MOSQUITO BREEDING PLACES

The members of the class will be paired for making a survey of mosquito breeding places in the town or in a portion of the city. Each couple of students will be assigned certain blocks or squares bounded by certain streets. The couple will make a map of the section of the town or city assigned them. The map of each block may be made as the students proceed with their survey. The location of the residences will be indicated on the map by the house numbers of the residences. The map of each block should be something like the size of the sheets of paper in the loose leaf notebooks and should be made on such paper. With red ink the students are to indicate the location on the map of artificial containers of water found and of natural pools of water or streams which might serve as breeding places for mosquitoes.

In examining a residence and its surroundings the following named items should be sought and examined:

Roof gutters—whether sagging or clogged.
Troughs, for chickens, cows, etc.
Tin cans—are holes punched through the bottoms?
Broken bottles.
Barrels, tubs, etc.—screened with cloth or wire?
Cisterns, above ground—screened?
Wells and underground cisterns—are tops mosquito-proof?
Leaking hydrant, cut-off or pipe.
Drain of ice-box under the house.
Cesspool, open?
Open privy, with wet soil around in which larvae might develop.
Places where water is discharged from pipes leading from sinks and bath, in cases of houses not connected with sewer. This is one of the most prolific sources of mosquitoes in small towns.
" Traps " of sinks, etc., not in use.
Tanks of unused flush closets.
Unused containers of water in house such as pitchers in " guest room," for instance.
Flower pots. Make careful exminations for larvae.

When a couple has finished their maps of blocks and indicated all desired information on them, the maps of the blocks may be pasted together on a large sheet of paper. The information of all the improvised maps may be transferred to a large map of the town which may be had from the city officials and presented to the officials of the town.

EXERCISE 33. THE GONOCOCCUS

Prepared slides, which consist of methylene blue stained smear of pus from a gonorrheal patient, will be exhibited in one or more demonstration microscopes. High power, or preferably the oil immersion objective, will be used.

Pus consists largely of white blood corpuscles which have migrated from many parts of the body to the site of infection for the purpose of engulfing and digesting the invading bacteria. The white blood corpuscles, also called pus cells, have irregular nuclei surrounded by comparatively wide cytoplasm. The gonococci may be

seen as deep blue dots within the cytoplasm of the pus cells, having been engulfed by the corpuscles. There may be any number of gonocccci in a single cell up to as many as fifty. If a good stain has been made and if a good oil immersion objective is had and if a good light is obtainable, then it may be seen that the round dots really consist of two cocci. That is, the gonococcus is a diplococcus. When the physician finds diplococci within pus cells from the genito-urinary passages he regards it as a definite diagnosis of gonorrhea.

Sketch two or three pus cells containing gonococci.

EXERCISE 34. THE TREPONEMA (OR SPIROCHAETE)

Treponema is the causal agent of syphilis. It is a spiral form and belongs to the group Spirochaetes rather than being a spirillum of the group Bacteria. One or two demonstration microscopes will be set up showing prepared slides of the Treponema. The oil immersion objective will be used. Stained as it is, the organism appears as a short black threads, spiral in form. A number of such organisms may be seen. **Sketch** two or three, making the sketches much larger than they appear in the microscope.

EXERCISE 35. STUDY OF POLLEN GRAINS OF VARIOUS PLANTS

The pollens of certain plants cause hay-fever which accounts for this exercise. The instructor will furnish pollens of several flowering plants. If it is late summer or early autumn pollen of ragweeds will be available, for ragweeds are among the most notorious causing hay-fever. Other pollens causing this disease are those of timothy and Bermuda grasses. Even though the pollens which cause hay-fever are unavailable at this season, it will be instructive to study other pollens which the instructor will furnish.

Put a tiny bit of the pollen in a drop of water on a slide. Use cover glass. Study with both low and high power. Many pollen grains have fantastic figures on their surfaces or are of fanciful shapes.

Draw two or three grains of each kind of pollen furnished. Make the drawings large enough to show any peculiarities of the grains.

Are the pollens used in this exercise wind-carried? Only wind-borne pollens can cause hay-fever. Of course, not all wind-borne pollens cause the disease.

EXERCISE 36. TESTING FOODS FOR SUGAR

Materials Needed: Benedict's *Qualitative* Solution; test tube; corn syrup; Bunsen burner; raw or baked sweet potato and Irish potato.

Procedure: The test described here is a test for a particular sugar, dextrose (also called glucose and grape sugar).

Into a test tube put about two inches of Benedict's qualitative solution. Heat over a flame to boiling point to see if the solution changes color, which it does if improperly made or if it has deteriorated. If no color change occurs, add a drop or two of corn syrup. Heat to boiling point again for two or three minutes. Allow to cool in room temperature. If dextrose is present in the syrup, a green, yellow, or red color appears on cooling, if not before. Make record of findings in notebook.

With a knife scrape off fine particles of raw or baked sweet potato and put into

test tube. Add two inches of Benedict's Qualitative Solution and test in same manner as with the syrup.

Test an Irish potato in the same way as the sweet potato was tested.

Record: Make record of the results obtained in notebook.

EXERCISE 37. TESTING FOODS FOR STARCH

Materials Needed: Test tube; tincture of iodine; a nut; Irish potato; sweet potato; wheat flour; corn starch.

Procedure: Into a test tube put a tiny pinch of corn starch. Add an inch or two of water. Add a drop of tincture of iodine.

Examination and Record: When iodine is added to the starch suspension, what color appears? If the color appears black, dilute with water until a distinct blue color is revealed. When iodine is added to a substance and a blue color appears the presence of starch is shown.

Test in the same manner wheat flour, the " kernel " of the nut, Irish potato and the sweet potato. Record results of all these tests in notebook. Name all the foods which are fairly rich in starch.

EXERCISE 38. MICRO-CHEMICAL STUDY OF STARCH GRAINS IN IRISH POTATO

Materials Needed: Irish potato; safety razor blade; iodine, diluted about 50 per cent with water; slide and cover glass.

Procedure: With a safety razor blade cut as thin a slice as possible from an Irish potato. The slice should be no larger than a dime or a nickel. Put the slice of potato into a drop of water on a slide. If necessary another drop of water may be put upon the potato, in order that it be immersed. Cover with cover glass.

Examination and Record: Examine the thin edge of the potato first under low power, then under high. It will be seen that there are a number of starch grains within a cell, surrounded by a cell wall. With the high power and with the diaphragm of the microscope adjusted so as to admit a proper degree of light, it will be seen that the starch grains have rather fantastic contoured markings upon their surfaces. **Sketch** two or three starch grains, showing the contoured lines. Show also the cell walls of the potato within which the starch grains are located. In this drawing the starch grains should be drawn about the size of the end of a small finger.

After the drawing has been made, with a medicine dropper place a drop of the diluted iodine at the edge of the cover glass and allow the iodine to run under. Examine the starch grains within the area of the iodine. Of what color are the starch grains?

EXERCISE 39. TESTING FOODS FOR FATS

Materials Needed: Lard, nuts; test tube; dilute osmic acid; sheet of white paper.

Procedure: Put a piece of lard the size of a pea in a test tube and melt it. Add a drop of dilute osmic acid. Be careful to conserve the osmic acid, for its cost is exceedingly high.

Examination and Record: What color appears when osmic acid is added? A black color shows the presence of fat.

Test in the same manner the "kernel" of a nut.

Also crush a piece of the kernal of a nut on a sheet of white paper. A permanent transparent spot is left. This, too, may be regarded as a simple test for fats.

Make records of these tests in notebook.

EXERCISE 40. TESTING FOR PROTEINS

Materials Needed: Test tube; egg white, raw or boiled; strong nitric acid; ammonium hydroxide; boiled or roasted lean meat; boiled beans; 1 per cent solution of copper sulphate; sodium hydroxide. '

Procedure: Into a test tube put an inch or two of water. Add a little egg white, raw or boiled. Add 8 or 10 drops of strong nitric acid. Boil over flame till the egg white becomes a lemon yellow color. Cool for 2 minutes. Now, add a few drops of ammonium hydroxide. The yellow color becomes a deep orange color, which is the test for proteins.

Test in the same way boiled or roasted lean meat and boiled beans.

Record: Record results in notebook. Name all the protein foods you can.

The test for proteins described above is known as the Xanthoproteic test. Another test for proteins is the Biuret test, described as follows:

Put a little egg white, boiled or raw, into a test tube which contains an inch of water. Add a drop or two of 1 per cent solution of copper sulphate, then strong sodium hydroxide. A violet color is the test. Lean meat and boiled beans may be tested in the same manner. Record results.

Which of these two tests for proteins do you prefer?

EXERCISE 41. THE ACTION OF A PROTEASE (PEPSIN)

Enzymes which split proteins are called **proteases**; those which split starches and sugars are known as **diastases**; while those which split fats are spoken of as **lipases.** In the following experiments, the action of each of these three general kinds of enzymes is demonstrated.

Materials Needed: Artificial gastric juice; 0.4 per cent hydrochloric acid; commercial dried pepsin; 2 test tubes; white of egg; glass tubing of about ¼ inch diameter, inside measure; small file.

Procedure: Gastric juice is secreted by glands located in the walls of the stomach. It contains about 0.4 per cent hydrochloric acid, an enzyme called **pepsin,** and a number of salts. An artificial gastric juice is readily made by adding 0.4 per cent hydrochloric acid to commercial dried pepsin, the latter usually being extracted at the packing house from the hog's stomach. See formula in Appendix B, this book.

Into a test tube put 5 to 10 cc. of artificial gastric juice, and into another test tube 5 to 10 cc. of 0.4 per cent hydrochloric acid. Add to each tube a small quantity of boiled white of egg cut into very small pieces. Place in incubator at body heat for 24 hours or longer.

Instead of adding small piece of boiled white of egg in manner described above, the egg may better be prepared in the following manner: Pour the egg white into a very large test tube. Into the test tube put several pieces of small glass tubing, each piece a little longer than the test tube. The egg white will fill the glass tubing. Now, set the large test tube and contents in a water bath, the water extending as high as the egg within the tube. Boil till the egg has coagulated completely in the

tubing. Remove the pieces of glass tubing from the test tube and with a file cut into pieces a half inch long. Drop a short piece of the tubing (containing coagulated egg white) into a test tube of artificial gastric juice, and another piece into a tube of 0.4 per cent hydrochloric acid. Incubate at body heat for 24 hours, or longer.

Examination and Record: After 24 hours of incubation, is the egg white still present in the glass tubing or is it dissolved or digested? In which of the two tubes has the digestion occurred? Will hydrochloric acid alone digest protein? Which portion of the gastric juice changes the egg white from a solid substance to a soluble substance? Make record and answer questions in notebook.

EXERCISE 42. ACTION OF A LIPASE (PANCREATIC)

Materials Needed: Fresh whole milk, drawn from cow on same day test is to be done; neutral litmus solution (see Appendix B) or azolitmin powder; sodium carbonate or cooking soda; pancreatin, which may be had from a drug house; test tube.

Procedure: The laboratory instructor will obtain 1 or 2 quarts of fresh whole milk. He will add neutral litmus solution (or azolitmin powder) to give the milk a distinct blue color. If the milk happens to be acid, he will add enough sodium carbonate or cooking soda to make it slightly alkaline and distinctly blue, with the litmus in it. (When milk is freshly drawn from cow it is slightly alkaline, but becomes acid as bacteria split the milk sugar to form lactic acid.)

The student will take 1 or 2 inches of the litmus milk in a test tube. To the contents of the test tube add as much powdered pancreatin as can be secured on the point of a pocket-knife blade. Set the tube in the incubator at body temperature (why?) or put in any warm place for a couple of hours (or until next day, if absolutely necessary).

Examination and Record: Watch the color change which occurs. Acid is being produced. Do you think the acid is derived from the splitting of the milk fat into fatty acids (and glycerine) by the lipase in the pancreatin? In your notebook write up the experiment and explain what occurred in the milk.

EXERCISE 43. ACTION OF A DIASTASE (PTYALIN)

Materials Needed: Soda cracker; mortar and pestle; test tube; tincture of iodine; Benedict's *qualitative* solution (or Fehling's solution); mortar and pestle.

Procedure: Crush a small piece of cracker in a mortar with pestle and put into a test tube with an inch or two of water. Test for starch by adding a drop or two of tincture of iodine. The appearance of a blue color shows starch to be present in the cracker. Make record of the result.

Into a test tube put 2 inches of Benedict's solution. Heat to boiling point to see whether the solution has deteriorated. If it has deteriorated it changes color on boiling. If the solution is good, then add some crushed cracker to the tube and test for Dextrose (glucose or grape sugar) by boiling the mixture. The appearance of a green, yellow or red color shows the presence of Dextrose. Make record of result.

Now, chew a piece of cracker about an inch square. Retain it in the mouth for 3 minutes. Does the cracker become slightly sweet? Deposit the mixture of cracker and saliva in a test tube containing 2 inches of Benedict's qualitative solution. Test for Dextrose by boiling the mixture. Record results.

Record: Make record of the results of each of the tests of this exercise in notebook. There is a diastase called **Ptyalin** in the saliva. Explain why dextrose was found in the last of the experiments in this exercise.

EXERCISE 44. PREPARATION OF A DAY'S BALANCED DIETARY FOR YOURSELF

(1) Determine your weight and exact height, without shoes. Make record.

(2) Considering your weight, height, age, and sex, determine whether you need a fattening dietary or a reducing one; whether you should have one for a sedentary person or an active person; or whether you should have anti-constipation menus. Determine this by using the tables in Appendix A.

(3) Calculate the total number of calories *you* need for one day, considering your activity and condition of weight.

(4) Calculate the number of calories which should be protein, say 10 per cent of the total calories for a young adult.

(5) Subtract the protein calories needed from the total number of calories needed. This remainder indicates the number of calories which should be carbohydrate and fat. The proportion of carbohydrates and fats with reference to each other is not of great importance probably, excluding the consideration of fat-soluble vitamins which the fats might contain. Perhaps it might be about as well to include the carbohydrate and fat calories together in a lump mass rather than to separate and proportion them.

(6) Select the food articles desirable for the day; assign and apportion them to the respective meals.

(7) By reference to the table in Appendix A showing caloric values of the selected food articles, calculate the quantity of each food needed for each meal.

(8) Checking back through the tentative dietary, examine to find if the vitamins, especially C and D, have been included; to see if the minerals, particularly calcium and iodine (in iodized salt), have been given consideration. Also consider whether sufficient roughage has been included.

Copy the accompanying "Diet Checking Chart," then transfer your finished dietary to the chart copy and place in your notebook.

Diet Checking Chart

Use one, two, or three *plus* signs to indicate that the particular food contains small, medium, or large amounts of the minerals or vitamins, or woody roughage. Do not attempt to indicate the relative amounts of P–P Factor (Vitamin G) nor of Vitamin E.

Give particular attention to Vitamins C and D content of dietary.

Food	Measure	Total Calories	Protein Calories	Minerals		Vitamins						Roughage
				Ca.	Iodine	A	B	C	D	E	P–P (G)	
Breakfast..												
Lunch....												
Dinner....												

EXERCISE 45. ANALYSIS OF URINE

Each student will bring to the laboratory a specimen of his or her urine, voided on same day analysis is to be made.

The instructor will furnish a specimen of urine which contains albumen. This specimen containing albumen may be secured from a doctor or hospital; or it may be normal urine to which some egg-white has been added. The instructor also will furnish a specimen of urine which contains sugar (dextrose or glucose or grape sugar). This specimen of urine might have come from a physician or a hospital, or it may be normal urine into which the instructor has put grape sugar. The instructor furthermore may furnish the class with urine from a patient having Bright's disease of the kidneys. Urine from cases of Bright's disease contains *casts* from the uriniferous tubules of the kidneys. Urine containing pus cells (white blood corpuscles) or red blood corpuscles may be furnished.

Presence of albumen usually is indicative of Bright's disease. Presence of sugar in the urine usually indicates diabetes.

(1) Tests of Urine for Albumen.

This is known as the qualitative test by Purdy's modification of the heat and acetic acid method.

Materials Needed: A test tube; a test tube clamp; a saturated salt solution; acetic acid which has been diluted 50 per cent with water; a sample of urine containing albumen; a sample of the student's urine; Bunsen burner.

Procedure: Fill a test tube two-thirds full of the urine known to contain albumen. Add saturated salt solution to the amount of about one-sixth of the volume of the urine. Add also 5 to 10 drops of the 50 per cent acetic acid. Mix by rolling the tube between the hands. Over a flame boil the upper inch of the mixture. A white cloud in the upper portion of the mixture indicates presence of albumen. Hold the tube at a distance of two feet and against a black background so as to better see any faint cloud. Make record of findings in laboratory notebook.

The student will now test his own urine for albumen in the same manner. Make record of each.

(2) Tests of Urine for Sugar.

This is known as the *qualitative* test by Benedict's method.

Materials Needed: Benedict's *qualitative* solution; a sample of urine containing sugar; a sample of the student's urine.

Procedure: Put 2 inches of Benedict's *qualitative* solution in a test tube. Heat over flame to boiling to see if the solution changes color, which it does if improperly made or if it has deteriorated. If no color change occurs, add 8 or 10 drops (not more) of the urine known to contain sugar. Heat to boiling point again for two or three minutes. Allow to cool in room temperature. If sugar is present in the urine, a green, yellow, or red color appears on cooling, if not before. Make record of findings in notebook.

The student will test his own urine for sugar in the same manner and make record in notebook.

(3) Microscopic Examination of the Urine.

Let the pathologic urine from a case of Bright's disease stand in a glass container, preferably of the shape of an inverted cone, for at least an hour or two. Or the urine may be run through a centrifuge according to directions of the instructor. After the urine has settled or after it has been centrifuged, pour off nearly all of the clear supernatant fluid. With a pipette put a drop of the sediment on a slide and

cover with cover glass. Examine with both low and high power for bodies which will be shown by the instructor in figures in textbooks, such bodies as casts; mucous threads; white blood corpuscles (pus cells); various kinds of crystals; red blood corpuscles; and epithelial cells. In examining for these bodies the diaphragm of the microscope should be so adjusted that there will be a low degree of light admitted to the microscope. A few epithelial cells, mucous threads, or certain kinds of crystals in urine may be without any health significance, that is, these bodies may be found in normal urine. White blood corpuscles (pus cells) in urine indicate that there is an infection in the kidneys or bladder or somewhere in the urinary tract.

The student will make microscopic examination of the sediment of his own urine in the same manner as was made of that of the pathologic urine.

In reporting on the anaylses of the two urines done above, copy the following outline in your laboratory notebook twice and use the outline to indicate what was found in the urines examined above.

Urinalysis Report Form
- Physical Characteristics of Urine:
  - Color: straw, lemon, amber, wine?
  - Odor: aromatic, ammoniacal, fruity?
  - Appearance: clear, cloudy?
  - Specific gravity (determine with urinometer)?
  - Reaction: acid, alkaline, neutral (use litmus paper)?
- Albumen: present or absent?
- Sugar: present or absent?
- Microscopic examination:
  - Casts: present or absent?
  - Mucous threads?
  - White blood corpuscles (pus cells)?
  - Crystals?
  - Red blood corpuscles?
  - Epithelial cells?

EXERCISE 46. PERIODIC MEDICAL EXAMINATION

The student should form a practice of having periodic medical examination made once a year during the rest of life, preferably on his birthdays. Such practice might save him a number of years of life.

This examination should be made by a physician who is a member of the local county medical society. Make inquiry of the secretary or president of the society of your county as to the membership of any physician whom you propose to have make your medical examination. If any given physician does not belong to the county medical society, be assured there is a reason, and a good one.

The student will make a typewritten copy of the following blank form, which is a modification of one prepared and published by the American Medical Association, Chicago, Ill. Take the typed copy with you when you go to your physician for examination.

Examination Record

The following is to be filled in by the examining physician. The physician may omit from the written record matter relating to personal defects, etc., which the subject might not care to be put into writing.

Name.......................................Date.......................

1. Height........ { Weight, present.... usual...... } I should weigh..... { Pulse: Bl. Pres. { Sys....... Dias...... } Sitting........... After exercise..... 2 minutes later................. }

{ Hearing R............Vision R..............Corrected R............
L............ L.............. L............ }

Urine: appearance.........Sp. Gr..........Alb.........Sugar...........

Below record only the abnormal conditions.

2. Standing	3. Sitting	4. Lying down
Posture	Hair	Abdomen
Musculature	Eye reflexes	Reflexes
Nutrition	Nose	Sensation
Skin	Teeth	Liver
Superficial Glands	Gums	Spleen
Female Breast	Tongue	Kidneys
Hands	Tonsils	Prostate Gland
Arms	Pharynx	Female genitalia
Male Genitalia	Ears	Rectum (hemorrhoids)
Hernia	Chest	
Legs	Heart	
Feet	Lungs	
Romberg sign	Visceral Ptoses	

5. Summary: Defects of function and structure, and errors of habit.
6. Advice given by physician:

Signature of Physician....................................

Address....................................

EXERCISE 47. SCORING MY HEALTH RECORD

The following outline is a modification of "Personal Health Standard and Scale," by Thomas D. Wood, M. D., Teachers College, Columbia University. Copies of the Scale may be had from Bureau of Publications, Teachers College, New York City.

Copy the following outline in your notebook and score your health record and health habits. It will be noted that the possible score to be attained is 100 points. In scoring yourself on any given item, score proportionately according to your best judgment, if you are not perfect as relating to that item.

Personal health and efficiency involve certain subjective and objective factors and evidences.

	Possible score	My score
I. Subjective factors and evidences of health.		
a. Enjoyment and zest in work and play	1	
b. Feeling of being rested and refreshed in morning and not more than wholesomely tired at bedtime	1	
c. General attitude of cheerfulness and confidence in relation to life and freedom from persistent worry and anxiety	1	
d. Good appetite and relish for food	1	
e. Freedom from regularly recurring or persisting physical pain and discomfort	1	
f. Ability to work with comfort and satisfaction 8 hours a day, $5\frac{1}{2}$ or 6 days in the week	1	
II. Objective factors and evidences of health.		
A. Hygienic program.		
1. Diet.		
At least one cup of milk daily	2	
At least three large servings of greens (cooked or uncooked) in a week	2	
Fresh fruit once a day	1	
Some vegetable other than potatoes every day	2	
Some food necessitating mastication for every meal	1	
Eating no food between meals	2	
Eating sweets only at end of meal	2	
Drinking at least four glasses of water daily	2	
Eating three regular meals daily	1	
2. Devoting $\frac{1}{2}$ to 1 hour daily to vigorous physical exercise	3	
3. Daily tonic bath and skin friction with towel of rough, hard texture	2	
4. Brushing teeth at least twice daily in approved way	2	
5. At least one satisfactory bowel movement daily, with regular attention to this function	3	
6. Giving 8 to 9 hours in bed, and to sleep, daily in a well-ventilated room	3	
7. Lying down and resting 10-20 minutes between 11 a.m. and 2 p.m. each working day	1	
8. Devoting 1 to 2 hours daily (in addition to daily exercise) to social recreation or recreative reading, or other recreative occupation	3	
9. Keeping one full day each week for rest from regular work	3	

	Possible score	My score
10. Using at least two afternoons or evenings a week, in addition to the seventh day, for activities other than study	3	
11. Dressing hygienically.		
Clothing protecting against sudden changes in temperature	2	
Shoes sensible in shape, guarding against changes in height of heels	2	
12. Keeping weight within standard range for health not more than 10 per cent below nor 15 per cent above standard for age and height	3	
B. Freedom from remediable health handicaps and defects including:		
1. Heart defects	3	
2. Thyroid defects	3	
3. Lung defects	3	
4. Defective posture	3	
5. Defective teeth	3	
6. Eye defects	3	
7. Defects of ears and hearing	3	
8. Diseased tonsils	3	
9. Defective nutrition	3	
10. Skin disorders	3	
11. Weak arches	3	
12. Visceroptosis (fallen viscera)	4	
13. Muscles undeveloped	3	
C. Freedom from susceptibility to those diseases for which specific immunity is practically obtainable by vaccination.—Smallpox, Typhoid	3	
D. Freedom from susceptibility to those infections (e.g. colds) which result from unhygienic habits of living and remediable health handicaps	3	
E. Freedom from metabolic errors (evidenced by urinalysis) and other less obvious defects which are revealed only by regular, thorough, physical examination	3	
Total	100	

EXERCISE 48. RECORD OF DENTAL EXAMINATION

The student should form the practice of visiting a dentist for an examination at least once a year. It may save teeth or even health.

This examination should be made by a dentist who is a member of the local county dental society. There are many incompetent dentists and many who are inelligible to become members of the county society.

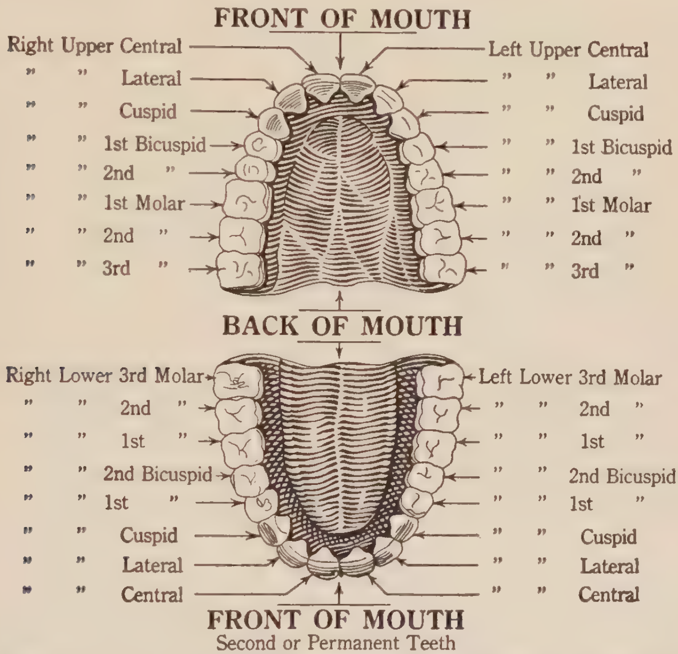


FIG. 66.—Diagram of the arrangement of the teeth. (From "Care of the Teeth," a bulletin of the Metropolitan Life Insurance Co., New York.)

The student will write up the examination in his notebook. He will mention any defects reported by the dentist, and any recommendations made. State whether you had the dentist make corrections suggested by him. Have the dentist indicate which of your teeth were defective by marking the appropriate teeth shown in Fig. 66.

EXERCISE 49. WEIGHT RECORD, WEEK BY WEEK

The student will copy the following table in his notebook and keep a weekly record of his weight, as determined by scales in the classroom. In determining what you should weigh refer to the Height-Weight Tables in Appendix A. For measuring your height the shoes must be removed.

My Height..........													I Should Weigh..........				
My Weight, Week by Week																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

EXERCISE 50. MAKING A TRIANGULAR BANDAGE

Materials Needed: A piece of muslin 36 inches square, which is freshly boiled and dried; scissors; soap; 10 per cent formalin solution.

Procedure: Students will work in couples. The triangular bandage is the best suited type of bandage for general first-aid measures.

First wash the hands carefully with soap. Use a table which has been wiped with a cloth moist with a good disinfectant, 10 per cent formaldehyde solution (formalin) being acceptable. After the table has dried, a piece of muslin 36 inches square will be folded diagonally. In this condition the muslin may be used as a triangular bandage. Or, the triangle may be cut along the folded edge to make two triangular bandages.

It is of great importance that the muslin be freshly boiled and dried, that the top of the table be sterilized, and that the hands be clean. Such care will probably make it unnecessary to sterilze the bandage after it is made.

EXERCISE 51. MAKING A ROLLER BANDAGE

Materials Needed: Gauze, 3 inches wide and about 3 yards long, freshly boiled and dried; scissors; soap; 10 per cent formalin solution.

Procedure: Students will work in couples. This type of bandage is not much used by the first-aid worker, but is much used by the surgeon.

The roller bandage consists merely of a strip of muslin. For bandaging the arm or leg a 3-inch width is used with a length of 3 to 6 yards. For the bandaging of a finger the material used is three-fourths of an inch wide and a yard long, or less.

First, wash the hands thoroughly with soap. Disinfect the table to be used with a cloth moistened in 10 per cent formalin. Roll the strip of gauze tightly into a very compact roll, as if ready for placing in the first-aid kit or medicine case.

In applying the roller bandage to a limb, for instance, the tapering circumference of the limb may necessitate the making of the **Reverse**. In making the Reverse the bandage is turned about the limb a few times, then turned one-half over each time thereafter, the outer side of the bandage becoming the inner side and in direct contact with the limb. The Reverse should not be made directly over a bone which comes near the surface, over the shin, for instance.

EXERCISE 52. MAKING A FOUR-TAILED BANDAGE

Materials Needed: The roller bandage made in the preceding exercise; scissors.

Procedure: Students will work in couples. The four-tailed bandage is used most for bandaging the head.

Wash the hands thoroughly with soap and disinfect the table with 10 per cent formalin solution, as in preceding exercises. The four-tailed bandage may be made from a roller bandage. Using the roller bandage made in the preceding exercise, cut or tear it from each end toward the middle, the two tears lacking about four inches of meeting in the middle. Apply the bandage to a supposed wound on the head. A compress should be applied directly to the wound and under the four-tailed bandage. The " tails " may be tied about the head in different directions and thus assure the maintenance of the compress in its proper place.

The four-tailed bandage may be made from gauze which is six inches wide.

Bandages should be firmly applied. But they must not be so tight as to occlude the flow of the blood through the vessels. They must not cause blueness or coldness of limb, for in such a condition the tissues may die in a short time and amputation of the limb may become necessary to save the patient's life. In bandaging feet or hands, leave the toes and fingers so that they may be seen and their color may be frequently observed. Wet bandages will shrink as they dry and therefore must not be used.

EXERCISE 53. MAKING A COMPRESS

Materials Needed: A strip of gauze about 3 inches wide and a yard long; scissors; soap; 10 per cent formaldehyde solution. Gauze should be freshly boiled and dried.

Procedure: Students will work in couples. Wash the hands with soap and disinfect with formalin the table to be used.

Fold the strip of gauze a number of times so as to make a compress about three inches square. Compresses, of course, may be made of varying sizes, the size depending upon the use to which it is to be put. Compresses are to be applied directly to wounds. They should be extremely clean, preferably sterile.

The three types of bandages made in preceding exercises and compresses of about two sizes should be made up and kept in homes, schools, and workshops for emergencies.

EXERCISE 54. TO STOP THE BLEEDING OF A BLOOD VESSEL

Materials Needed: A handkerchief (large); pencil or small stick; small stone or other object.

Procedure: A broken or cut artery is a serious matter for the life of the subject, usually more serious than that of a vein. The blood from an artery flows in spurts due to the pulse, which distinguishes the bleeding artery from a bleeding vein. The high pressure of the blood in an artery prevents coagulation of the blood at the cut. To stop a bleeding artery, apply a **tourniquet** (Fig. 67) between the injury and the heart. Why apply it toward the heart from the wound of an artery?

A tourniquet may be made and applied as follows: Tie a handkerchief, or a roller bandage, very loosely above the elbow of your partner, supposing that he has a cut

artery in the lower arm. By pressing the thumb upon the patient's arm immediately above the elbow and on the inner surface of the arm the artery may be occluded and the blood flow stopped at the wound in the lower arm. When the place has been found above the elbow where pressure of the thumb stops the pulse in the wrist, apply the stone to that area and tighten the handkerchief till the stone is pressed against the artery and stops the pulse in the wrist. The handkerchief may be drawn tightly about the arm by inserting a pencil or small stick and twisting the handkerchief until it is closely bound about the arm. A tourniquet should not be allowed to remain longer than an hour; it might cause mortification of the flesh in lower arm and hand.

FIG. 67.—Correct way to apply a tourniquet to stop a bleeding arm. (From "First Aid in the Home," by Metropolitan Life Insurance Co., New York.)

To stop a bleeding vein the tourniquet should be applied on the side of the wound furthest from the heart. Why?

If bleeding appears serious, send for a physician at once but attempt to stop the bleeding while awaiting the doctor.

EXERCISE 55. STOPPING NOSEBLEED

Materials Needed: Two thick cloths, each folded several times; ice water.

Procedure: Students should work in couples. Let one of the partners play the patient with the bleeding nose. The patient sits in a chair with his head resting on the top of the chair-back. The second partner will apply cloths wet with ice water to the back of the neck. The patient should hold the end of the nose between the fingers.

If bleeding is prolonged, call a physician.

EXERCISE 56. TREATING A BROKEN OR CUT SKIN

Materials Needed: Tincture of iodine or mercurochrome; compress; adhesive tape; vaseline or unguentine.

Procedure: Assume that your partner has suffered a wound on the lower arm. Avoid touching the supposed wound with your fingers. First apply mercurochrome or tincture of iodine to the wound. Then apply vaseline or unguentine or other oily ointment to an absolutely clean compress and fasten over the wound with adhesive tape. The oily application will prevent formation of a hard surface on the wound and will also prevent sticking of the cloth to the surface.

Contrary to the popular notion, no ointment hastens the healing of a wound. The multiplication of the cells and the progress of repair can not be hastened with remedies.

It is better not to dress a wound at all than to apply unclean dressing. Use no water on the wound.

If a deep closed wound is caused by a nail, splinter, or other sharp instrument, a physician should attend. In such wounds there is danger of tetanus or lockjaw. Explain why the tetanus bacillus is likely to multiply in deep closed wounds.

EXERCISE 57. TREATMENT OF SHOCK

"Shock" is a profound depression of the central nervous system resulting from severe injury. It is also called collapse or prostration. There may be unconsciousness. It is extremely serious. Send a hurry call for a physician. While awaiting the physican give treatment described below.

Let your partner be the patient. Or the instructor may employ small boys to act as patients. Lay the patient on a table or floor. Place him on his back with the head lower than the trunk to encourage flow of blood to the brain. Loosen any tight clothing, including collar and belt, the body should be kept warm, since heat loss increases shock. Apply "smelling salts," if available. Rub the arms and legs toward the body to aid the circulation of the blood, which is very weak in shock. Be careful, however, to prevent loss of body heat.

EXERCISE 58. TREATMENT FOR FAINTING

Place the patient on back with head on a level with the trunk, or slightly lower. As soon as the normal amount of blood returns to the brain, consciousness will return. Usually no other treatment is necessary. If further treatment becomes necessary, then treat as for shock.

EXERCISE 59. TREATING FRACTURED (BROKEN) BONES OF LIMBS

If a physician can be had at once, do not disturb the patient. But if arrival of physican must be necessarily delayed or if patient must be moved, give the following treatment: Treat for shock first, if it exists, for shock is more serious than the fracture. If the broken ends of the bone have penetrated through the skin (called *compound* fracture) pour tincture of iodine or mercurochrome into the wound, if these are avilable. Do not allow hands, clothing, or dirt to come in contact with wound. Cover wound with *clean* cloth. If the patient must be moved before attention of a physician can be had, splint the limb in the following manner:

Place the limb in its natural position. Apply a board or boards, umbrella, or net wire, or even a stick, to the limb, with padding of torn shirt or of grass between the splint and the limb. (Fig. 68.) With cloth of torn shirt, or with stockings, bandage the splints to the limb. The two limbs may be bound together if it is a leg that is broken. Bear in mind the bandage must not be so tight as to cause blueness or coldness in the lower portion of the limb. Look for these frequently. In removing the patient avoid bending the limb at the point of fracture. The splints should be sufficiently long to reach well beyond the joints next above and below the wound.

Let one partner be a patient with a broken thigh (Fig. 68). The other partner or partners will splint the limb for removal of the patient. Or the instructor may hire small boys as patients. Using long splints, bind them to the leg as low as the middle of the lower leg. The splints should extend up as high as the ribs and should be bound with roller bandage or other improvised bandage by passing the latter around the abdominal region of the trunk. The person so bandaged may be placed upon and carried with an improvised stretcher, to be made in the next exercise.

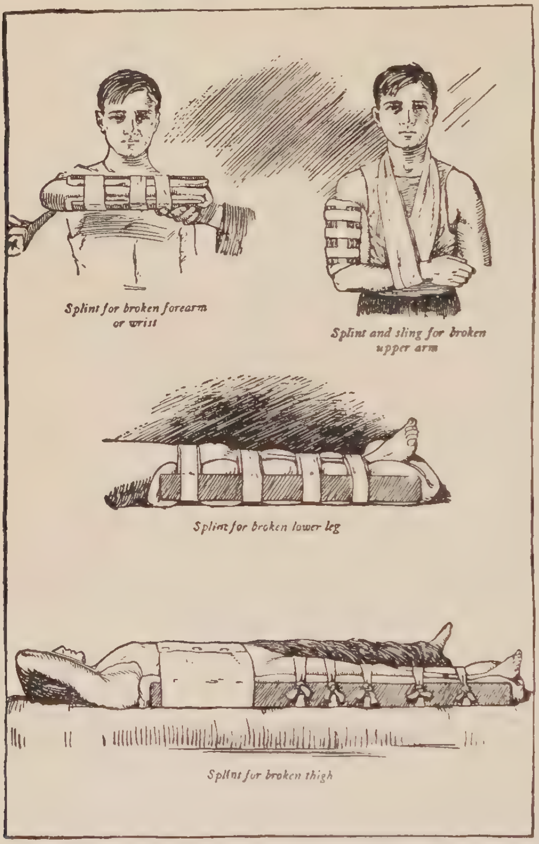


Fig. 68.—Various types of splints. (From "First Aid in the Home," a bulletin for distribution by the Metropolitan Life Insurance Co., New York.)

Let one partner be the patient with a broken lower arm. Splint the (Fig. 68) arm. With a triangular bandage, or an improvised one, made from a shirt or from two or more handkerchiefs, prepare a sling of the type shown in Fig. 69.

EXERCISE 60. TO MAKE AN IMPROVISED STRETCHER

With sticks 6 or 8 feet long and with coats make an improvised stretcher. The sleeves of the coats may be tied about the sticks. Or the sticks may be passed through the sleeves of the coats and the coats buttoned. Upon this improvised stretcher may be carried a supposedly injured patient.

EXERCISE 61. REPLACING DISLOCATIONS

Dislocations of fingers may be remedied by pulling strongly the patient's finger while pressing with thumb and fingers of the other hand upon the dislocated joint.

For replacing other dislocations it is better that a physician be summoned.

If it happens that a physician is unav ilable and cannot be had for many hours, replacement of a dislocation of the arm at the shoulder may be attempted by the first-aider in the following manner: Lay the patient upon the ground and on his back. Assuming that it is his right arm which is dislocated, take the shoe off your right

foot. Seat yourself on the ground beside the patient's waistline on his right and facing him. Put your right unshod foot into his armpit. Taking the wrist of the dislocated arm, pull it toward yourself and inward toward his trunk. In this way your foot may force the dislocation back into place. It should be repeated that if a physician is available within a few hours, it is best to await his arrival. The first-aider attempting to replace a dislocated shoulder may tear tissues and produce a more serious injury.

EXERCISE 62. TREATMENT OF SPRAINED JOINTS

In a sprain the ligaments about the joint are torn. Torn ligaments are very slow in healing, one reason being the fact that ligaments have no blood vessels within them.

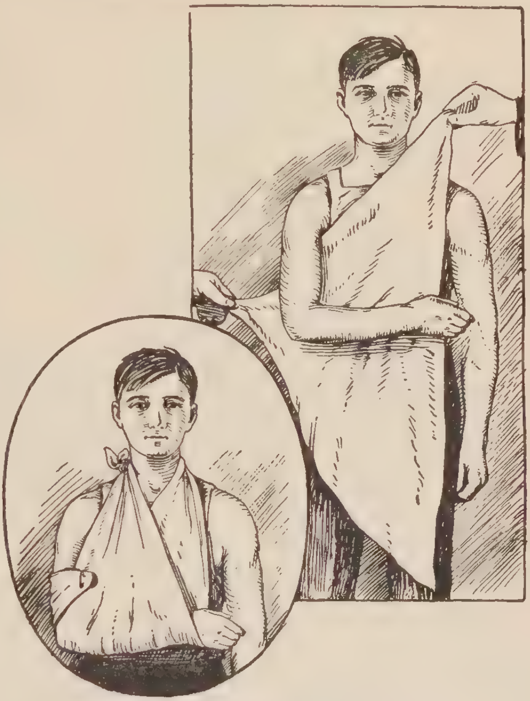


FIG. 69.—The making of a sling for the arm. (From "First Aid in the Home," Metropolitan Life Insurance Co., New York.)

Supposing your partner has a freshly sprained ankle: raise the injured joint and place it above the level of the body as he lies upon the table. This will reduce the blood flow into the sprained region and will reduce the amount of swelling. To the injured ankle, apply "cold-packs," that is, cloths wet with iced water. This further reduces the blood supply and swelling. Continue the cold-pack several hours. Prevent any motion of the injured joint. After 24 hours have passed, hot-packs may be applied. The hot-pack increases the blood supply, and encourages the excess fluid in the injured tissues to pass out of those tissues. But the hot cloths should not be applied until 24 hours shall have elapsed after the injury was done.

EXERCISE 63. TREATMENT OF BRUISES

Let one of the partners assume the role of a patient with a badly bruised lower leg (or a small boy may be hired as patient). The other partner will apply cold-packs to the bruised area for a few hours only, as was done in the treatment of sprains. After 24 hours from the time when the bruise was received, apply hot-packs in manner describe for sprains.

If a "black eye" has already become black, due to flow of blood from the tiny broken blood vessel into the tissues beneath the skin, then apply hot-packs half an hour three times a day. The hot-pack increases the blood supply, and the increased number of white blood corpuscles will the sooner absorb and carry away the shed blood which is beneath the skin.

EXERCISE 64. RESUSCITATION FOR DROWNING, GAS POISONING, OR ELECTRIC SHOCK

The same general method of resuscitation is used for all of these. Treatment consists of artificial respiration, the Schaefer method of artificial respiration being regarded as the better method (Fig. 70).

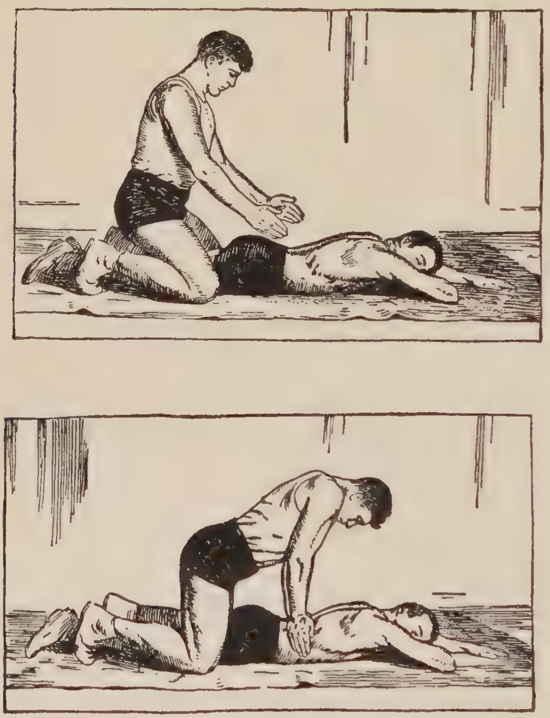


FIG. 70.—Artificial respiration methods for drowning, asphyxiation and electric shock. (From "First Aid in the Home," a bulletin for distribution by the Metropolitan Life Insurance Co., New York.)

Procedure: Let your partner or a small boy be a supposed patient. Place him on his breast. Stretch arms at length above the head. Bend one arm so that the forehead rests on it. Put clothing or thick object beneath the chest at level of lower ribs so that water may run out of lungs, in case of drowning. Open the mouth. Kneel beside or astride the body. Place palms of hands over lower ribs and let weight of operator's body fall on hands. The pressure is then released. This is repeated at the rate of about twelve times a minute, every five seconds. Use a watch if available. If no watch is had the operator should judge the time for repeating the artificial respiration movement by his own frequency of breathing. The attempt to resuscitate should continue three to four hours, unless the body has become both cold and stiff.

In rescuing a person who is in contact with a live wire, do not touch his flesh. If his coat is dry, pull him away by it. Or the wire may be removed with a dry stick. Better stand on newspaper or dry board or other non-conductor while rescuing the body. Wet objects may transmit the electric current to yourself.

EXERCISE 65. THE RESCUE OF DROWNING PERSONS

If possible avoid going into the water to rescue. If available use boat, pole, rope, or some object on which the drowning person may rest. If the rescuer must go into the water, he should take off all clothes possible, certainly the shoes and coat. Approach the person from behind (Fig. 71). Take him by the hair or back of the collar. Avoid letting the person get hold of you; keep him at arm's length. If he grasps you strike him in the face as hard as possible; or break his hold by methods shown in Figure 72. Take the drowning person to shore by one of the methods shown in Figure 73.

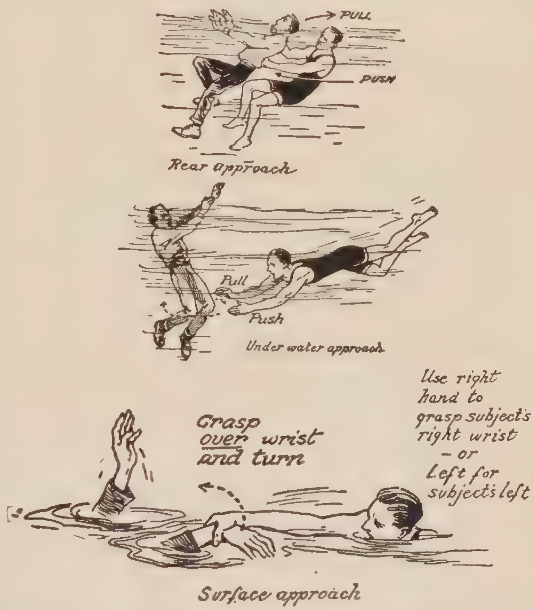


FIG. 71.—Approaching the drowning person. (From "Life Saving Methods," a bulletin for distribution by American Red Cross, Washington, D. C.)

Many Boy Scouts and Red Cross workers are very proficient in demonstrating methods of rescuing the drowning, and such persons may be used in demonstrating methods of rescue, provided no efficient swimming instructor may be available.

Students will practice rescue methods in a swimming pool. They will practice methods of breaking the hold which the drowning person may have upon the rescuer. The students will furthermore practice methods of taking the drowning person to shore.

If it happens that any student in the class is unable to swim, he will be taught by a swimming instructor as a part of this course.

EXERCISE 66. TREATMENT OF BURNS OR SCALDS

Materials Needed: Vaseline, or unguentine, or lard, or flour and water; a compress; adhesive tape.

Procedure: Let one partner play the patient. Suppose the burn is a relatively large one on the back of the hand. Apply vaseline or lard or unguentine to the burned area to exclude the air. Or a mixture of flour and water may be applied. Then apply a compress by means of adhesive tape or by wrapping a roller bandage three inches in width around the hand. In case the bandaging is used, attach the end by means of adhesive tape.

If the burn is very large or very deep, call a physician. But the first-aid treatment should be given while awaiting the physician.

EXERCISE 67. IMMUNITY: A STUDY OF PHAGOCYTOSIS

Materials Needed: A smear of pus from the urinary passages of a gonorrheal patient; methylene blue stain; microscope with oil immersion lens.

FIG. 72.—Methods of breaking the hold of the drowning person on the rescuer. (From "Life Saving Methods," by American Red Cross, Washington, D. C.)

Procedure: The instructor will furnish a dried gonorrheal smear obtained from a physician, clinic or hospital. Apply a half dozen drops of methylene blue stain for about 15 to 30 seconds or possibly 1 min. Wash off stain beneath a slowly running hydrant, holding the slide up near the mouth of the hydrant. Shake surplus water off slide and dry slowly and carefully over a flame.

Examination and Record: Examine slide under oil immersion lens, by putting small drop immersion oil on slide, then letting oil objective down into oil and adjusting. If the stain is neither too heavy nor too light, white blood corpuscles (pus cells, or phagocytes) will be seen to be stained blue. The nuclei of these pus cells are stained deep blue and are very irregular in shape. Around the nuclei is the more lightly stained cytoplasm. Within the cytoplasm of a few of the pus cells will be seen deep blue round dots. These dots are the gonococci which have been phagocytized by the white blood corpuscles. There may be as many as 50 gonococci in some of the phagocytes. Some gonococci will also be found outside phagocytes.

Draw two or three phagocytes containing gonococci. Make the drawing of a phagocyte about the size of a five-cent piece.

Write a paragraph on Phagocytosis in your notebook.

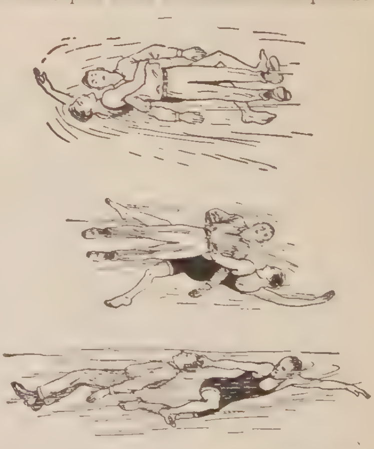


FIG. 73.—Methods of carrying the drowning person to shore. (From "Life Saving Methods," a bulletin for distribution by American Red Cross.)

EXERCISE 68. BACTERIOLOGICAL EXAMINATION OF MILK

Materials Needed: Agar tube; bottle of milk; thermometer; 1000 cc. of sterile water; sterile Petri dish; a 1 cc. pipette; a 1000 cc. graduated cylinder; 1500 cc. flask.

Procedure: Melt an agar tube in water bath and cool to 43° C. Shake the milk sample thoroughly so as to distribute the cream evenly throughout the milk. With

boiled or sterile water, dilute a portion of the milk in the ratio of 1 part milk to 10,000 parts water by putting 0.1 cc. of milk into 1000 cc. of water. Of the diluted milk put 1 cc. (equivalent to .0001 cc. of undiluted milk) into a sterilized Petri dish. Pour the agar, which has been kept at 43° C., into the plate with the diluted milk. Tilt dish about to mix. When the agar is thoroughly hardened, invert the plate and incubate.

Examination and Record: Observe at intervals of 24 hours and of 48 hours and record the number of colonies found at each time. Be sure to count all tiny specks. Each colony is probably derived from a single bacterium which was in the milk. Calculate the number of bacteria which were present in 1 cc. of the undiluted milk. Make record in notebook.

If your plate appears not to have been successful, examine your neighbor's plate and report on it.

EXERCISE 69. TO SHOW THE EFFECT OF PASTEURIZATION ON THE BACTERIAL CONTENT OF MILK

Materials Needed: Two sterilized test tubes that are plugged with cotton; beaker for water bath.

Procedure: Put undiluted milk into two sterilized test tubes which are plugged with cotton. Fill them one-third full with milk. Heat one of the tubes in a water bath at 60° C. for 30 minutes. Mark the tubes and leave both at room temperature for 3 days.

Examination and Record: At the end of three days observe the odor and appearance of each tube. Which tube soured and decomposed most? How do you account for the difference?

EXERCISE 70. TESTING MILK FOR THE FAT CONTENT (BABCOCK TEST)

Materials Needed: Babcock test bottles; special pipettes for the Babcock test (graduated 10 cc. pipettes may be substituted); Babcock test machine or centrifuge; commercial sulphuric acid; bottle of milk; a container for boiling water.

Procedure: This is known as the Babcock Test for percentage of fat. With a pipette put 17.6 cc. of milk, which has been previously shaken and well mixed, into a Babcock test bottle. Add 17.5 cc. of commercial sulphuric acid. Mix by shaking. When the curd is dissolved, centrifuge at moderate speed for 4 minutes. Add boiling water with great care till contents of bottle come up to base of the bottle's neck. Centrifuge again, for 1 minute. Add more boiling water very carefully till top of fat column comes to about the figure "7" on the neck. Centrifuge again for one minute.

Examination and Record: Note the column of fat in the neck of the bottle. Read by subtracting the number at the lower end of the fat column from the number at the upper end of the fat column. The difference obtained is the percentage of fat in the milk. Make record. Learn from the City Health Department what percentage of fat is required of milk sold in the city. Does the fat content of the milk examined by you conform to the requirements of the law in your city?

EXERCISE 71. INSPECTION AND GRADING OF A DAIRY

The form below is a modification of one prepared by the Alabama State Board of Health. This form is arranged for grading of dairies under the classification provided in the United States Public Health Service Standard Milk Ordinance. The item numbers below, in parentheses, correspond to the item numbers of Grade A Raw Milk in the Standard Milk Ordinance.

Copy this form in your notebook and in the first right-hand column, while making an inspection of the dairy, checkmark those items only which are found to be deficient.

Name of Dairy and of Manager..
Location of Dairy..
Signature of Dairyman..
Names of Students in Party..

	Checkmark, if Deficient	Grade, if Deficient
Cows:		
(1) Tuberculin tested within 12 months........	....	C
Milking Barn:		
(2) Lighting—deficient or liberal..............	....	B
(4*a*) Floor construction—concrete, sewer drain....	....	B
(4*b*) Floor cleanliness—washed clean............	....	B
(5) Walls and ceiling—clean, cobwebs, etc.......	....	B
(6) Barnyard—drainage, clean...............	....	B
(7) Manure—disposed of daily in manner to prevent breeding of flies..................	....	C
Milk House:		
(8*a*) Floor construction—concrete, sewer drain....	....	D
(8*b*) Walls and ceiling—clean, cobwebs, etc.......	....	D
(8*c*) Lighting—deficient or liberal.............	....	D
(8*d*) Screens—fit well into openings, not torn.....	....	D
(9) Cleanliness and flies....................	....	D
Toilet:		
(10) Of sanitary construction—even sanitary privy must be more than 100 feet from milking barn, milk house, and source of water.....	....	D
Water Supply:		
(11) Accessibility, adequacy, sanitary quality.....	....	D
Utensils:		
(12) Joints and seams, easily cleaned...........	....	C
(13) Cleaning, scrubbed in alkaline solution......	....	D
(14*a*) Sterilization with steam..................	....	B
(14*b*) Sterilization with boiling water............	....	C
(15) Storage—prevent contamination of utensils...	....	D
(16) Handling—after sterilization no part of person or clothing to touch a part of utensil which is later to come in contact with milk.	....	D
Milking:		
(17) Udders and teats—washed with disinfectant, dried..............................	....	D
(18) Flanks—free of visible dirt................	....	D
(19) Hands—washed in disinfectant and dried....	....	D
(20) Clothing—clean........................	....	D
(21) Milk stools—clean, do not contaminate hands.	....	D
(22) Immediate removal of each pail to milkhouse..	....	D
Cooling:		
(23*a*) To 50° F. within 1 hour and till delivery.....	....	B
(23*b*) To between 50° and 60° F...............	....	C
Bottling and Capping:		
(24) By machine or by disinfected hands, caps disinfected—(full credit if delivered in cans).	....	C
Health Certificates of Employees:		
(25) Within 12 months......................	....	C

Bacterial Count. (Make test of sample of the milk or see last report of Health Department.)..
Fat Content. (Make test for fat or see last report of the Health Department.)

The bacterial count did not exceed 50,000 per cubic centimeter (Grade A); or was between 50,000 and 200,000 (Grade B); or between 200,000 and 1 million (Grade C); or between 1 million and 5 millions (Grade D). The student will underline the proper figures above to indicate the bacterial count.

The final determination of the grade of the milk will be made by looking for the *lowest* letter of the alphabet in the grade column. That is, look for the lowest letter opposite any checkmark made. This lowest letter is the grade of the milk, provided the bacterial count is not of lower grade.

GRADE OF MILK..

EXERCISE 72. A MILK PASTEURIZING PLANT

Members of the class in groups of 10 to 20 persons per group will visit a pasteurizing milk plant. Describe the process from time the milk enters the plant until it is pasteurized, bottled and stored temporarily on ice. Make a sketch to show the route and processing of the milk in this plant. The following will suggest some of the questions which you should be able to answer as a result of the visit.

Does the plant operate a clarifier? What is the principle involved in this machine? Does clarification of milk remove bacteria? Or is it more for the purpose of removing dirt from the milk? Ask to be shown the sediment from the clarifier.

Is the floor made of concrete? Is the floor kept moist?

Is the house well screened? Any flies present?

Are there any pipes leading from the pasteurizing vats and having their valves outside the vats in such way that milk may run down into pipe to the valve, thus finding a " pocket " in which the milk does not become heated sufficiently?

To what degree is the milk heated and for how long?

Are the workers' hands sterilized before they begin the " run " ? If so, with what are they sterilized?

Do the hands of the workers come in contact with the milk at any stage in the processing?

What other precautions are taken to prevent either pathogenic or non-pathogenic bacteria from gaining entrance to the milk? After the milk has passed through the pasteurizing vats how is it cooled down and to what degree?

What of the location of toilets with reference to the room in which the pasteurizing is done? Does any open directly into the room?

Are there any adverse criticisms to be made with regard to hygienic conditions or methods of operation of this plant?

What was the bacterial count of the milk from this plant as shown in the last monthly report of the city health department?

What was the fat content as shown in the last monthly report of the health department?

EXERCISE 73. INSPECTION OF AN ICE CREAM FACTORY

Students will inspect an ice cream factory in groups of 10 to 20 persons. Notebook and pencil will be needed.

From what source or sources does this factory obtain its raw milk or cream? At what distances from the city?

What percentage fat is contained in " plain " ice cream from this factory? What is the state law with regard to the minimum fat content of ice cream?

Is the floor constructed of concrete? Is it kept moist?

Is the house screened? Any flies present?

Any toilet opening directly into the room or rooms where the milk and cream are handled?

Is the plant operating a clarifier? Ask to be shown sediment from the clarifier, if one is operated.

Is the milk pasteurized before being made into ice cream? Are there any valves in pipes leading from the pasteurizing vats into which milk might flow and escape sufficient heat?

To what degree is the milk heated and for how long?

Are the workers' hands sterilized before they begin their work?

Do the hands of the workers come in contact with the milk or ice cream?

Any adverse criticisms with regard to hygienic methods or conditions?

Write up a description of the processes from the time milk enters the plant until it is stored as ice cream.

EXERCISE 74. SURVEY OF HYGIENIC CONDITIONS IN AN INDUSTRIAL INSTITUTION EMPLOYING WOMEN AND CHILDREN

A cotton mill, or other large manufacturing establishment, will be visited. Write your observations as to the following:

Apparent health of the workers.

Age of the workers. Do you suspect the state child labor laws are being violated? Number of hours per week that the women, especially, work. What are the requirements of your state regarding the maximum numbers of hours per week that women shall be employed?

Conditions with regard to effort of the corporation to eliminate dust.

Ventilation and lighting of workrooms.

Safety appliances to prevent accidental injury to workers.

Maintenance of physician or nurse and clinic for rendering first-aid to injuries.

Does the corporation carry accident insurance for its employees? Does the state require that such corporations carry accident insurance for its employees?

What other activities relating directly or indirectly to the health of employees are maintained by the corporation?

Is there a federal child labor law or has any such ever been proposed in Congress? If so, what were the arguments made by those opposed to such federal enactment?

EXERCISE 75. THE CITY HEALTH DEPARTMENT

Students will visit the City Health Department and report on the organization of the department and on the purposes and duties of each bureau or subdivision.

Offer criticisms on the organization of the department and make suggestions.

The student will also name and describe each kind of record he sees in the department.

He will examine the Mortality Record of the preceding year and list the diseases causing the deaths, in order, and showing the number of deaths occurring from each disease or accident. Indicate which of these diseases are preventable.

Are the ten leading causes of death in the city or county of your college the same as the ten leading causes in the United States as a whole? (See copy of the most recent volume of Mortality Statistics published by the United States Census Bureau.)

EXERCISE 76. THE COUNTY HEALTH DEPARTMENT (OR UNIT)

The students will visit the County Health Department or Unit. In your notebook describe its organization. Explain the duties of each member of the department or unit. Make criticisms and suggestions of the organization as it is at present.

Is it a standard health unit, as defined by the International Health Board?

Does it receive any financial support from the International Health Board or from the state?

Look over the last annual report of the County Health Unit made to the State Health Department and mention what appeared to be the chief items in the work of the county unit.

EXERCISE 77. THE COUNTY PUBLIC HEALTH ASSOCIATION

The students will visit the monthly meeting of the Board of Directors of the County Public Health Association and report in their notebooks the proceedings of the meeting.

Name the purposes for which the association exists. Mention the projects which the association has before it at present.

What relation exists between the association and a well-known state organization, which you will name? The state organization is a branch of what noted national organization?

Upon what do these organizations depend for funds for maintenance?

EXERCISE 78. THE AMERICAN RED CROSS

The students will visit the monthly meeting of the Executive Committee of the local Red Cross chapter and report the proceedings of the meeting in his notebook.

What comprise the activities of the Red Cross as a national organization in times of war?

Name the peace-time divisions of the local chapter and the purposes and duties of each division.

Give a sketch of the history of the Red Cross in only a few sentences. (See any encyclopedia.)

In what way does the Red Cross secure funds for maintenance and its peace-time enterprises?

EXERCISE 79. THE WORK OF THE SCHOOL PHYSICIAN, DENTIST, OR NURSE

A small group of students will arrange to visit a school physician, dentist or nurse while at work with the school children, and will make record of observations. Take pencil and notebook. Make record of the number, or percentage, of children revealing the various kinds of defects found. Write up your visit in your notebook for laboratory and field exercises.

EXERCISE 80. EXAMINING THE EYE FOR CORRECT VISION AND DISEASE

Materials Needed: Snellen's Eye Test Chart, which may be obtained from an oculist for about one dollar. Instead of the Snellen Chart, a Reading Card may be used. The Reading Card costs nothing. Either the Snellen Chart or the Reading Card may be ordered from Bausch & Lomb Optical Co., Rochester, New York.

Procedure: Wash your fingers clean with soap. Placing the fingers at the lower portion of the lower eyelids of your partner, pull the eyelids down so that their inner

surfaces may be seen. But do not allow the fingers to touch the inner surfaces. Observe the appearance of the inner surfaces. Do they appear inflamed or irritated? Do you find what appear to be little yellowish stones beneath the linings of the inner surfaces? If so, this may be a case of Trachoma or "granulated" lids. The upper lids need not be examined.

To test correctness of vision by means of Snellen's Eye Chart: The chart has several horizontal rows of letters on it, the rows of letters being of different sizes. The pupil is supposed to be able to read the different rows at different distances. The usual distance selected in testing is 20 feet. At 20-foot distance the pupil should read a certain row of letters, which row is indicated on the chart. (Some charts have the distances indicated in meters, abbreviated M., instead of feet. A meter is about 40 inches.) The student is placed at 20 feet from the chart, directly in front of it. He is expected to cover one eye with a piece of cardboard. He should not use his hand, for he may press the hand upon the eye, which should not be done. If the student reads the 20-foot row of letters and also reads the rows of smaller letters, he is far-sighted. If he is unable to read the 20-foot line, but reads the rows of larger letters, then he is near-sighted.

Instead of the Snellen Chart one may use a small Reading Card with sentences in different sized print. One certain sentence is to be read at a distance of 15 inches from the eyes. Looking with one eye, if the student moves the card nearer than 15 inches toward his eye, he is near-sighted. If he moves the card further than 15 inches from the eye, he is far-sighted.

On the Snellen Chart is a figure of heavy lines which are not parallel. On most of the charts these lines are arranged radially, like the spokes of a wheel. If some of the lines appear blacker than others to the student the eye is astigmatic.

Record of Health Examination

(Made by Teacher)

(Copies of this Record may be made by mimeograph or by pupils)

Name of School.................................Grade................

Name and Address of Pupil..

Age..........Height..........Weight..........Should weigh.........

Eyes: Near-sight, far-sight, astigmatism { Right..........................
Left..........................

Conjunctivitis or Trachoma..

Ears: Acuity of hearing { Right..........................
Left..........................

"Running" ears...............Frequent earache....................

Teeth: Clean......................Decay..........................

Gums: Abscesses...................Pyorrhea.......................

Tonsils: Enlarged.................Infected.......................

Breathing Obstructions..

Glands of Neck Enlarged...

It is advised that you have a thorough medical examination by a competent dentist—physician—or specialist in..............................diseases.

....
Signature of Teacher

Date.......................

EXERCISE 81. EXAMINING THE EAR FOR DISEASE AND ACUITY OF HEARING

In schools where no medical inspection of pupils is had the teacher may, with a little trouble and study, train herself for recognition of *pronounced* physical defects and for recognition of symptoms of incipient illness. Any physician of the community will gladly offer suggestions. He might even demonstrate to the teacher in his office by showing her normal and abnormal conditions, in children's mouths, for instance.

If the teacher considers that she has found physical defects or disease, she should not feel or speak too surely. Her opinion might prove to be incorrect when the cases are seen by a physician or dentist. After discovery of what she believes to be a physical defect or a diseased condition, the teacher should call at the home of the child and tactfully endeavor to see that the parents take the child to a physician or dentist. Parents make little response to written notices of their children's defects.

Students of this class will practice these exercises on each other.

Procedure: Observe the child's ears to determine if there is any "running" of the ear and question to learn whether the child is subject frequently to earache.

Test the hearing in the following manner: Select a vacated room which is absolutely quiet and free of noise coming from the outside. Place the subject at one end of the room. Go to the other end of the room and whisper numbers. If the numbers are not heard, move closer to the subject and whisper again. Perhaps it is best that the numbers whispered be changed with each trial. Continue this till the numbers are heard and repeated. Count the number of steps or measure the number of feet distant from the child. Make record. In testing the hearing of different persons, make an effort to have the whisper uniformly loud and distinct in all cases. After having thus tested the hearing of several pupils, go over your records of distances and determine which pupils possess least acuity of hearing. Try such pupils again.

There is no very accurate method of testing the hearing. The one described above is probably as accurate as any method.

EXERCISE 82. EXAMINATION FOR OBSTRUCTIONS IN BREATING PASSAGES

Procedure: Have the student close his mouth and see that he keeps it closed. With your finger, press upon side of the nose near the end so as to close one nostril. Have the student breathe through the other nostril. Test the second nostril in the same manner. If his breathing is obstructed in either nostril, it may be due to enlarged adenoids, or to a fleshy growth (polyp) in the nose, or to the partition or septum in the nose being turned aside so as to close one or both nostrils.

EXERCISE 83. EXAMINING FOR ENLARGED OR INFECTED TONSILS

Procedure: With a small wooden tongue blade, 100 of which may be purchased at a drug store for a few cents, depress the tongue of the student and direct him to breathe deeply in and out. Observe the tonsils at the sides in the back portion of the mouth (Fig. 74). After examining the tonsils of several pupils the teacher will be able to determine whether the tonsils of a given student are greatly enlarged or not. Notice whether the students' tonsils contain small white spots, which may be infections or pus "pockets" and which extend deep into the tonsils. Enlarged or infected tonsils should come to the attention of a physician.

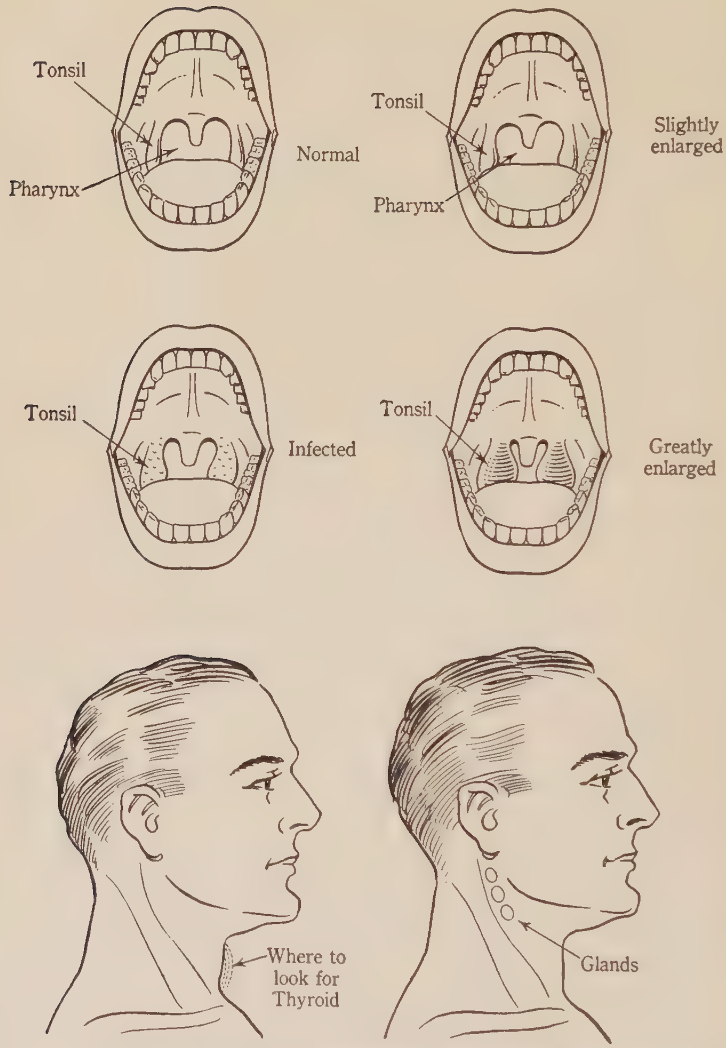


FIG. 74.—The tonsils, the thyroid and the cervical (neck) glands. (Modified from bulletin of Medical Division, the Detroit School System.)

EXERCISE 84. EXAMINING THE TEETH AND GUMS

Procedure: With the student seated and facing a window make a systematic examination of the teeth and then of the gums. Use a tongue blade to hold the tongue apart from the teeth and gums and to hold the cheek apart from the outer sides of the teeth and gums. Go systematically around the outsides of the lower teeth and gums, then systematically around the insides of the teeth and gums. Examine also the grinding surfaces of the teeth. Likewise, examine the upper teeth and gums. Look for cavities on the grinding surfaces and sides of the teeth. Watch out for abscesses of the gums. Also examine for pyorrhea, which is a disease occurring between the gums and teeth. In pyorrhea the gums have retreated toward the roots of the teeth. If pyorrhea is found, press the finger upon the gums and pus will likely be seen. Pyorrhea perhaps occurs more on the gums of the lower front teeth than in other parts.

The hands should be carefully washed with soap after examining the mouth of one student and before examining that of another.

EXERCISE 85. EXAMINING FOR ENLARGED CERVICAL (NECK) GLANDS

Procedure: With the student seated in a chair, stand behind and feel of the neck somewhat behind and below the ears. If the glands of this region are enlarged they can be felt beneath the skin as being about the size of peas or beans. Enlarged cervical glands frequently accompany infected throat or tonsils. Such persistently enlarged glands may indicate infection with the tuberculosis germ or others.

EXERCISE 86. SANITARY SURVEY OF A CITY SCHOOL

Students will make this survey in the afternoon, after school hours.

Copy the following outline in notebook and fill in information obtained. Mention the adverse hygienic conditions found and suggest recommendations for corrections.

Names of students in the survey party ....

....

Signature of a teacher or janitor in the school ....

Location of school ....

Number of children in this school ....

Playground: Area, sufficient or not ....

Drainage ....

Shade trees ....

Playground apparatus: Make list ....

Sufficient for the number of children ....

Toilets: Inside school building ....

Cleanliness ....

Obscene writing ....

Conditions for privacy ....

Heating: Method ....

Efficiency ....

Lighting: Over left shoulders only ....

Sufficient on dark days ....

Ventilation: Method. . . . .
Efficiency in both cold and cool weather. . . . .
Window shades: Color. . . . .
Repair. . . . .
Do they both lower from top and raise from bottom?. . . . .
Two shades or rolls—one for upper sash and one for lower?. . . . . . .
Color of walls in rooms. . . . .
Restful, cheerful, appearance in rooms. . . . .
Water: City supply. . . . .
Well. . . . .
Cistern. . . . .
Condition of well or cistern. . . . .
Wash basins and paper towels. . . . .
Drinking fountains. . . . .
Lunch room and warm lunches. . . . .
Blackboard: Position with reference to source of light. . . . .
Color. . . . .
Seats and desks adjustable to heights of students. . . . .
Cloakrooms: Open into class-rooms or into hallway. . . . .
Floors oiled. . . . .
Medical service: Physician to how many students. . . . .
Dentist—serves how many students. . . . .
Nurse—number of pupils served. . . . .
Room fitted for clinic. . . . .
Are physician, dentist, and nurse part-time employees?. . . . .
Is a well-rounded school health program maintained?. . . . .
Rest room for girls of 12 years and upward. . . . .
Other conditions. . . . .

EXERCISE 87. SANITARY SURVEY OF A RURAL SCHOOL

Copy the outline below in notebook and fill in information obtained in the survey. Write criticisms, mentioning unfavorable conditions found and making recommendations for improvement.

The survey should be made after school hours.

Name and location of school. . . . .
Signature of teacher or janitor. . . . .
Names of students in survey party. . . . .
. . . .
Number of children in the school. . . . .
Playground: Area. . . . .
Drainage. . . . .
Shade trees. . . . .
Playground apparatus. . . . .
List the apparatus. . . . .
Sufficient for the number of children. . . . .
Toilets: Inside school building. . . . .
Cleanliness. . . . .
Obscene writing. . . . .
Conditions for privacy. . . . .

Heating: Method..
Efficiency..
Lighting: Over left shoulders only..
Sufficient window space..
Light from north, south, etc..
Window shades: Color..
Repair..
Lower from top and raise from bottom........................
Walls: Color in rooms..
Restful, cheerful appearance in rooms..
Ventilation: Method..
Sufficient in both cool and cold weather........................
Water: Well, or cistern, or spring..
Sanitary structure of well, cistern, or spring........................
Bacillus coli test of the water..
Wash basins and paper towels..
Drinking fountains..
Lunch room and warm lunches..
Blackboard: Position with reference to source of light........................
Color..
Seats and desks adjustable to heights of students........................
Cloak-rooms open into class-rooms or into hallway........................
Floors oiled..
Medical service: Physician..
Dentist..
Nurse..
Amount of time given by physician, etc...
Room fitted for clinic..
Any attempt at a well-balanced school health program........................
Rest room for girls of 12 years and over..
Remarks on other conditions..

APPENDIX A

MODEL DIETARIES, HEIGHT-WEIGHT TABLES, FOOD VALUES CHART

Model Dietary I *

A DIETARY FOR A 150-POUND SEDENTARY PERSON WHOSE WEIGHT IS NORMAL

Fuel Value: 2400 Calories

	Measure	Weight, Ounces	Protein Calories	Total Calories
Breakfast:				
Grapefruit (C, B)	½ medium	7.6	7	100
Shredded wheat biscuit (B)	1 biscuit	0.9	13	100
Scrambled egg (A, B)	⅓ cup	2.5	24	110
Bacon	2 small pieces	0.3	7	50
Graham toast (B)	3 small pieces	1.2	14	100
Butter (A)	2 teaspoon	0.3	......	67
Top milk (10 oz.) (A, B)	¼ cup	2.1	9	100
Whole milk (A, B)	⅝ cup	5.1	19	100
Sugar	1 T. (scant)	0.5	......	50
Coffee	1 cup		0	0
				777
Luncheon:				
Cream of baked bean soup (B, A)	¾ cup	3.9	22	150
French rolls	1 roll	1.3	12	100
Butter (A)	½ T.	0.2	......	50
Apple pie	1 piece (3 in.)	4.8	9	300
Cream, thin (A, B)	2 T.	0.9	2	50
Sugar	2 teaspoon	0.3	......	40
Coffee	1 cup		0	0
				690
Dinner:				
Clear tomato soup (C, B, A)	½ cup	3.7	4	50
Saltines	2 crackers	0.3	3	33
Roast Veal (shoulder)	small serving	2.1	66	100
Roast Veal with stuffing	⅙ cup	0.8	9	100
Gravy (brown sauce)	3 T.	1.7	7	50
Boiled potatoes (C, B)	1 medium	3.6	11	100
Green peas buttered (B, A, C)	¾ cup	3.0	21	100
Lettuce (C, A, B), French dressing	1 serving	0.6	......	50
Snow pudding	1 cup	3.3	15	150
Boiled custard (A, B)	⅓ cup	2.2	13	100
Macaroons	2 macaroons	0.8	6	100
				933
Total for the day	....	....	293	2400

In this and succeeding dietaries the most important sources of the A, B, and C Vitamins will be indicated by these letters in parentheses after the food. When more than one letter is placed after any food, the one for which the food is most significant will be placed first.

* Modified from Rose's "Feeding the Family." By permission of the Macmillan Company.

Model Dietary II *

A FATTENING DIETARY FOR A SEDENTARY PERSON WHO SHOULD WEIGH 150 POUNDS

Fuel Value: 3450 Calories   Ordinary Requirement: 2500 Calories

	Measure	Weight, Ounces	Protein Calories	Total Calories
Breakfast:				
Grape juice (B)	1 cup	7.0	......	200
Farina with 4 dates (B)	¾ cup	7.0	14	200
Scrambled eggs (A, B)	½ cup	4.2	40	200
Toast	1 slice	0.5	7	50
Butter (A)	½ T.	0.2	......	50
Cream, thin (A, B)	⅞ cup	6.3	18	350
Sugar	2 T. (scant)	0.9	......	100
Coffee	1 cup		0	0
				1150
Luncheon:				
Creamed chicken (A, B) †	½ cup	3.2	32	200
on toast	1 slice	0.5	7	50
Lettuce (C, A, B)	1 serving	1.2	1	100
Saltines	3 saltines	0.4	5	50
Vanilla ice cream (A, B)	½ cup	4.0	12	200
Chocolate (A, B)	⅚ cup	7.8	33	250
				850
Dinner:				
Cream of corn soup (A, B)	1 cup	8.0	24	200
Roast beef	2½ slices	4.0	115	250
Baked potato (C, B)	1 medium	3.0	11	100
Buttered Lima beans (B, A)	⅜ cup	2.5	24	150
Whole wheat bread (B)	2 slices	1.4	16	100
Butter (A)	2 T.	0.9	......	200
Baked apple (C, B)	1 large	4.6	2	200
Cream, thin (A, B)	½ cup	3.6	10	200
Sugar	1 T. (scant)	0.5	......	50
				1450
Total for day	....	....	371	3450

* From Rose's "Feeding the Family." By permission of the Macmillan Company.
† From milk and butter.

Model Dietary III *

A REDUCING DIETARY FOR AN OVERFAT PERSON WHOSE WEIGHT AT NORMAL WOULD BE 150 POUNDS

Fuel Value: 1400 Calories Ordinary Requirement: 2500 Calories

	Measure	Weight, Ounces	Protein Calories	Total Calories
Breakfast:				
Orange (C, B, A)	1 large	9.5	7	100
Eggs (A, B)	2 eggs	4.8	54	150
Graham bread (B)	2 thin slices	0.7	7	50
Coffee (clear)	1 cup		0	0
				300
Luncheon:				
Bouillon	1 cup	8.5	21	25
Soda cracker	1 cracker	0.2	3	25
Halibut steak broiled with lemon	Large serving	6.0	122	200
Asparagus, plain (B)	10 stalks	8.0	16	50
Potato, boiled (C, B)	1 medium	3.6	11	100
Butter (for potato and asparagus) (A)	½ T.	0.3	......	50
Apple, raw (C, B)	1 medium	4.9	2	65
				515
Dinner:				
Raw oysters	12 oysters	7.2	49	100
Roast beef strictly lean	Large serving	5.8	162	250
String beans, plain boiled (A, B, C)	½ cup	2.0	5	25
Potato, boiled (C, B)	1 medium	3.6	11	100
Tomatoes, sliced, with vinegar, salt and pepper (C, B, A)	1 medium	7.7	8	50
Cheese, pineapple † (A, B)	....	0.4	12	50
Water cracker	1 cracker	0.1	1	10
Coffee (clear)	1 cup		0	0
				585
Total for day	....	....	491	1400

* From Rose's "Feeding the Family." Used by permission of the Macmillan Company.
† Roquefort, Swiss, Brie, or American may be substituted.

Model Dietary IV *

DIETARY FOR A LABORING MAN OF 150 POUNDS WHOSE WEIGHT IS NORMAL

Fuel Value: 3945 Calories Ordinary Requirement: 2500 Calories

	Measure	Weight, Ounces	Protein Calories	Total Calories
Breakfast:				
Oatmeal mush (B)	1½ cups	12.0	25	150
Creamed dried beef (A, B) †	⅚ cup	6.0	40	250
Old New England Corn Bread	Large slice	4.0	32	400
Oleomargarine	2 T.	0.9	......	200
Milk for cereal and coffee (A, B)	⅝ cup	5.1	19	100
Sugar for cereal and coffee	2 T. (scant)	0.9	......	100
Coffee	1 cup		0	0
				1200
Luncheon:				
Kidney bean stew (B, C, A)	1¾ cups	18.0	100	355
Rye bread (B)	¼ loaf	2.8	28	200
Oleomargarine	2 T.	0.9	......	200
Banana (B, C)	1 large	5.5	5	100
Molasses cookies	2 large	1.5	12	200
Milk for coffee (A, B)	3 T.	2.0	8	40
Sugar for coffee	1 T. (scant)	0.5	......	50
Coffee	1 cup		0	0
				1145
Dinner:				
Stuffed beef heart	1 serving	4.0	84	400
Potatoes, boiled (C, B)	2 small	5.4	16	150
Carrots (A, B)	2 small	5.0	5	50
White bread	⅜ loaf	3.9	42	300
Oleomargarine	2 T.	0.9	......	200
Date pudding (B)	1 serving	3.5	22	310
Brown sugar for clear sauce	2 T. (scant)	0.8	......	100
Milk for coffee (A, B)	3 T.	2.0	8	40
Sugar for coffee	1 T. (scant)	0.5	......	50
Coffee	1 cup		0	0
				1600
Total for day	....	....	446	3945

* From Rose's "Feeding the Family." Used by permission of the Macmillan Company.
† Vitamins from milk.

Some Anti-Constipation Menus *

(For Healthy Adults)

I

Breakfast:	An orange Cut oats, cream Bran muffins and honey Bacon
Luncheon:	Scalloped corn Triscuit Baked apple
Dinner:	Vegetable soup Roast beef Spinach (large serving) Baked potatoes (skins eaten) Cabbage salad Graham bread Steamed fig pudding, lemon sauce

II

Breakfast:	Stewed prunes Shredded wheat, cream Tomato omelet Graham toast
Luncheon:	Pork and baked beans Boston Brown Bread Sliced pineapple Oatmeal macaroons
Dinner:	Boiled mutton, caper sauce Stewed onions Lettuce salad, French dressing Bran wafers Lemon jelly, whipped cream

Two glasses of water or a glass of diluted lemon, orange, or other fruit juice should be taken each day, on arising.

* From Rose's "Feeding the Family." Used by permission of the Macmillan Company.

TABLE OF AVERAGE HEIGHTS AND WEIGHTS—MEN

AGE	5 ft. 0 in.	5 ft. 1 in.	5 ft. 2 in.	5 ft. 3 in.	5 ft. 4 in.	5 ft. 5 in.	5 ft. 6 in.	5 ft. 7 in.	5 ft. 8 in.	5 ft. 9 in.	5 ft. 10 in.	5 ft. 11 in.	6 ft. 0 in.	6 ft. 1 in.	6 ft. 2 in.	6 ft. 3 in.	6 ft. 4 in.	6 ft. 5 in.
15	107	109	112	115	118	122	126	130	134	138	142	147	152	157	162	167	172	177
20	117	119	122	125	128	132	136	140	144	148	152	156	161	166	171	176	181	188
25	122	124	126	129	133	137	141	145	149	153	157	162	167	173	179	184	189	194
30	126	128	130	133	136	140	144	148	152	156	161	166	172	178	184	190	196	201
35	128	130	132	135	138	142	146	150	155	160	165	170	176	182	189	195	201	207
40	131	133	135	138	141	145	149	153	158	163	168	174	180	186	193	200	206	212
45	133	135	137	140	143	147	151	155	160	165	170	176	182	188	195	202	209	215
50	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217
55	135	137	139	142	145	149	153	158	163	168	173	178	184	191	198	205	212	219

TABLE OF AVERAGE HEIGHTS AND WEIGHTS—WOMEN

AGE	4 ft. 8 in.	4 ft. 9 in.	4 ft. 10 in.	4 ft. 11 in.	5 ft. 0 in.	5 ft. 1 in.	5 ft. 2 in.	5 ft. 3 in.	5 ft. 4 in.	5 ft. 5 in.	5 ft. 6 in.	5 ft. 7 in.	5 ft. 8 in.	5 ft. 9 in.	5 ft. 10 in.	5 ft. 11 in.	6 ft. 0 in.
15	101	103	105	106	107	109	112	115	118	122	126	130	134	138	142	147	152
20	106	108	110	112	114	116	119	122	125	128	132	136	140	143	147	151	156
25	109	111	113	115	117	119	121	124	128	131	135	139	143	147	151	154	158
30	112	114	116	118	120	122	124	127	131	134	138	142	146	150	154	157	161
35	115	117	119	121	123	125	127	130	134	138	142	146	150	154	157	160	163
40	119	121	123	125	127	129	132	135	138	142	146	150	154	158	161	164	167
45	122	124	126	128	130	132	135	138	141	145	149	153	157	161	164	168	171
50	125	127	129	131	133	135	138	141	144	148	152	156	161	165	169	173	176
55	125	127	129	131	133	135	138	141	144	148	153	158	163	167	171	174	177

Height and weight taken with shoes on and coat and vest or waist off.
Prepared by Life Extension Institute.

FOOD VALUE OF AN AVERAGE SERVING OF CERTAIN FOOD MATERIALS *

Food	Important Nutrients Present												
	Approximate Amount of One Serving				Percentage of the Total Daily Requirement for an Average Adult			Distribution of					
								Vitamins			Calories		
	Measure	Weight, Ounces	Total Calories	Protein, Grams	Calcium, Per Cent	Phosphorus, Per Cent	Iron, Per Cent	A	B	C	Protein	Fat	Carbohydrate
Milk and Milk Products:													
Milk, whole	½ pt.	8½	170	8.5	44.1	17.2	3.9	+++	++	+	34	88	48
Buttermilk	½ pt.	8⅝	89	7.3	39.0	18.3	4.1	+	++	+	29	12	48
Cheese, American	cube 1 in.	⅔	89	5.8	28.1	10.5	1.8	++	*	*	23	63	3
Cheese, cottage	3⅔ T.	2	62	12.3	8.5	14.0	....	+	*	*	49	2	11
Cream, thin	2 T.	1	50	0.5	3.7	1.7	0.3	+++	++	+	2	43	5
Butter	pat 1 T.	½	100	0.3	0.3	0.1	0.2	+++	−	−	1	99	
Ice cream	⅔ cup	5	320	3.3	13.2	5.9	1.2	++	++	+	13	202	105
Fat and Salad Oils:													
Animal fat	1 T.	⅖	100	....	....	....	....	− to +	−	−	....	100	
Olive oil	1 T.	⅖	100	....	....	....	....	−?	−	−	....	100	
Cottonseed oil	1 T.	⅖	100	....	....	....	....	?	−	−	....	100	
Bread and Cereals:													
Bread, white	1 slice 3 × 3½ × ½ in.	⅔	50	1.8	0.8	1.3	1.2	?	+	−	7	3	40
Graham bread	1 slice 3¼ × 2 × ⅜ in.	½	33	1.3	0.9	2.1	2.1	+	++	?	5	2	26
Boston brown bread	½ in. slice, 3 in. diam.	1⅛	67	1.8	5.6	4.1	5.7	*	*	*	7	6	54
Bran, wheat	¼ cup	⅗	54	2.0	3.2	16.3	9.2	+	++?	−	8	3	43
Corn meal, cooked	⅔ cup	6	100	2.5	0.7	4.0	2.0	− to +	++	−	10	5	85
Hominy grits, cooked	½ cup	4¼	70	1.5	0.2	1.4	1.2	*	*	*	6	1	63
Macaroni, cooked	⅓ cup	2⅝	50	1.8	0.4	1.5	1.1	*	*	*	7	1	42

Oatmeal, cooked	⅔ cup	5¼	67	2.8	1.7	5.0	4.3	– to +	+ +	–	11	11	45
Rice, brown, steamed	¾ cup	4	100	2.5	0.4	4.5	3.9	+	+ +	–	10	7	83
Rice, white, steamed	¾ cup	4	100	2.3	0.1	2.0	1.7	–	–	–	9	1	90
Eggs:													
Egg, whole, in shell	1 egg	2½	70	6.3	4.7	6.5	9.5	+ +	+		25	45	
Egg, white	1	1	14	3.3	0.4	0.2	0.2	–	*		13	1	
Egg, yolk	1	⅜	56	2.8	3.0	5.0	8.6	+ + +	+		11	45	
Meat, Fish, and Poultry:													
Bacon, cooked	4-5 small slices	½	100	3.3	0.3	2.6	3.2	– to +	+	?	13	87	
Beef, lean, round, broiled	2 slices, 4×3×1⅛ in.	4	200	24.0	2.0	19.6	24.0	– to +	+	– to +	96	104	
Chicken, roast	1 slice, 4×2½×¼ in.	1⅓	100	12.8	1.1	10.4	12.7	*	+	*	51	49	
Fish, lean, broiled	1 slice, 4×2¼×1 in.	4	133	20.3	3.3	17.6	7.4	– to +	+	*	81	52	
Ham, boiled	1 slice, 4¾×6×⅛ in.	2	150	11.0	0.9	8.9	11.0	– to +	+	.	44	106	
Lamb, chop, broiled	1 chop	1⅛	100	10.0	0.9	8.1	10.0	*	+	*	40	60	
Lamb, roast	1 slice, 3½×4½×⅛ in.	1⅛	100	10.3	0.9	8.4	10.2	*	.	*	41	59	
Liver, calves', broiled	medium size serving	2⅜	100	15.5	1.3	12.6	15.5	+ +	+ +	+	62	38	
Mutton, roast	1 slice, 3×3¾×⅛ in.	1⅛	100	8.3	0.7	6.7	8.2	– to +	+	?	33	67	
Oysters, raw	½ cup	5⅜	75	9.3	11.9	17.4	44.6	*	*	+	37	18	20
Pork chop, lean, broiled	1 chop	2⅜	200	16.0	1.4	13.1	16.1	– to +	+	–	64	136	
Veal leg, lean, broiled	1 serving	4⅓	150	26.3	2.2	21.2	26.1	*	+	*	105	45	
Vegetables:													
Asparagus	4 stalks, 4 in. long	1½	10	0.8	1.8	1.3	3.0	*	+ + +	*	3	1	6
Beans, lima, dried	¼ cup	2	200	10.5	6.0	14.5	26.7	*	*	*	42	8	150
Beans, lima, fresh	½ cup	3	100	5.8	3.4	8.3	11.0	*	*	*	23	5	72

* From American Red Cross' "Text Book on Food and Nutrition." The chart is compiled by the Red Cross from various sources including Rose's "Feeding the Family," Macmillan Company; Rose's "Laboratory Manual"; and Sherman's "Food Products."

FOOD VALUE OF AN AVERAGE SERVING OF CERTAIN FOOD MATERIALS—*Continued* *

Food	Important Nutrients Present: Approximate Amount of One Serving				Percentage of the Total Daily Requirement for an Average Adult			Distribution of: Vitamins			Distribution of: Calories		
	Measure	Weight, Ounces	Total Calories	Protein, Grams	Calcium, Per Cent	Phosphorus, Per Cent	Iron, Per Cent	A	B	C	Protein	Fat	Carbohydrate
Vegetables (*Continued*)													
Beans, dried	¼ cup	1¾	171	11.3	12.0	17.7	23.1	+	+++	*	45	8	118
Beans, string, fresh	⅓ cup	1⅓	15	0.8	2.5	1.4	2.7	++	++	++	3	1	11
Beets	⅓ cup cubes	2	25	0.8	2.4	1.6	2.2	*	+	*	3	1	21
Cabbage, chopped	½ cup	1⅛	10	0.5	2.1	0.7	2.3	+	++	+++	2	1	7
Carrots, cooked	2 medium	4	40	1.0	7.4	3.0	3.5	++	+	+	4	2	34
Cauliflower	⅕ small head	2⅓	20	1.3	12.0	3.0	2.6	+	++	+	5	3	12
Celery	¼ cup	1⅛	6	0.5	3.8	0.9	1.1	+	++	*	2	......	4
Corn, fresh	1 ear 6 in.	4½	50	1.5	0.4	3.9	2.6	+	++	–	6	4	40
Corn, canned	⅓ cup	3⅜	100	2.8	0.9	7.7	5.3	*	*	*	11	11	78
Cucumber	⅜ cucumber 7 in. long	3¾	16	0.8	2.1	2.3	1.2	*	+	++?	3	2	11
Dandelion greens	½ cup	4⅓	75	3.0	19.3	6.6	22.0	++	++	+	12	11	52
Lentils, dried	3¾ T.	1½	150	11.0	6.9	11.3	24.7	*	++	–	44	4	102
Lettuce	¼ head	2⅓	12	0.8	4.0	2.0	6.3	++	++	+++	3	2	7
Okra	5 to 6 pods	2	20	0.8	6.7	0.8		*	++	*	3	1	16
Onions	3 to 4 medium	7⅛	100	3.3	10.3	7.0	6.7	– to +	++	++	13	6	81
Parsnips	½ cup slices	3	50	1.3	6.8	4.4	3.0	–?	++	*	5	3	42
Peas, dried	⅜ cup	2⅝	253	17.5	9.8	23.0	27.8	+	++	?	70	6	177
Peas, fresh	⅜ cup	1¾	50	3.5	2.1	4.8	5.7	++	++	++?	14	2	34
Potatoes, white, boiled 15 min.	**1 medium**	**3⅜**	**100**	**2.8**	**2.4**	**5.2**	**10.4**	+	++	++	11	1	88

Potatoes, sweet, baked	1 medium	6	200	3.0	4.7	5.6	5.4	++	+	*	12	10	178
Rutabaga, raw	⅜ cup	2	17	0.5	4.7	1.8	....	–?	++	++	2	1	14
Spinach, cooked	⅝ cup	5¼	25	0.8	10.5	5.4	25.1	+++	+++	+	3	2	20
Squash, cooked	½ cup	3⅞	55	1.0	3.2	1.4	4.8	++	*	*	4	5	46
Tomatoes, fresh	1 small	3⅘	25	1.0	1.9	2.1	2.9	++	+++	+++	4	4	17
Turnips, cubes, raw	⅓ cup	2¼	25	0.8	6.0	2.2	2.1	– to +	++	++	3	1	21
Fruits, Fresh:													
Apples	½ large	3¾	50	0.5	0.9	0.7	1.6	+	+	+	2	3	45
Banana	1 medium	4⅕	75	1.0	1.0	1.8	3.0	+?	+	+	4	4	67
Blackberries	½ cup	6	100	2.3	4.3	4.4	6.9	*	*	*	9	16	75
Cantaloupe	½ melon	9	50	0.8	3.3	1.4	2.4	*	*	*	3	....	47
Cherries, stoned	¼ cup	1⅛	25	0.3	0.9	0.7	0.8	*	*	*	1	2	22
Cranberries, fresh	½ cup	2	25	0.3	1.4	0.5	2.1	*	*	+	1	3	21
Grape fruit	½ large	7½	100	1.8	5.9	2.7	3.9	*	++	++?	7	4	89
Grapes, white	22	3⅔	100	1.3	2.8	2.4	2.1	*	+	+	5	15	80
Huckleberries	½ cup	2⅓	50	0.5	2.0	0.4	4.0	*	*	*	2	4	44
Lemon juice	1 T.	½	5	....	0.4	....	....	?	++	+++	....	....	5
Olives, green	4 medium	⅘	50	0.3	3.0	0.1	3.2	*	*	*	1	41	8
Oranges	1 medium	7⅕	75	1.3	9.8	2.3	1.9	+	++	+++	5	2	68
Orange juice	½ cup	4	50	....	5.0	1.4	1.5	+ to ++	++	+++	....	....	50
Peaches	3 medium	10½	100	1.5	5.7	4.3	4.9	*	*	++	6	3	91
Pears	2 medium	6⅓	100	1.0	3.6	3.1	3.1	*	+	*	4	6	90
Pineapple	2 slices 1 in. thick	8⅓	100	1.0	6.1	4.8	7.7	+	+	++	4	6	90
Plums	3–4 large	4⅔	100	1.3	3.6	2.9	3.9	*	*	*	5	....	95
Raspberries	⅜ cup	1¾	33	0.8	3.6	1.9	2.0	*	*	++	3	5	25
Rhubarb	1 cup	3⅘	25	0.5	7.0	2.5	7.2	*	*	+	2	7	16
Strawberries	⅔ cup	4½	50	1.3	7.8	2.7	6.8	*	+	++	5	7	38
Fruits, Dried:													
Apricots	9 halves	1⅓	100	1.8	3.4	3.3	3.5	*	*	*	7	3	90
Dates, unstoned	3–4	1	100	0.5	2.8	1.2	5.7	*	*	*	2	7	91
Figs	3 large	2⅛	200	2.5	15.2	5.6	12.7	*	*	*	10	2	188
Prunes	4 medium	1⅔	100	0.8	2.7	2.6	6.7	+	+	–	3	....	97
Raisins	¼ cup	1	100	0.8	2.8	2.9	9.3	–	+	–	3	9	88

* From American Red Cross' "Text Book on Food and Nutrition." The chart is compiled by the Red Cross from various sources including Rose's "Feeding the Family," Macmillan Company; Rose's "Laboratory Manual"; and Sherman's "Food Products."

FOOD VALUE OF AN AVERAGE SERVING OF CERTAIN FOOD MATERIALS—*Continued* *

Food	Important Nutrients Present												
	Approximate Amount of one Serving				Percentage of the Total Daily Requirement for an Average Adult			Distribution of					
								Vitamins			Calories		
	Measure	Weight, Ounces	Total Calories	Protein, Grams	Calcium, Per Cent	Phosphorus, Per Cent	Iron, Per Cent	A	B	C	Protein	Fat	Carbohydrate
Nuts:													
Almonds	12–15 nuts	½	100	3 3	5.5	5 4	4.0	+	+	*	13	76	11
Peanuts	20–24 single nuts	⅗	100	4.8	1.9	5.5	2.4	+	++	*	19	63	18
Pecans	12 meats	½	100	1.3	1 8	3.4	2.3	*	+	*	5	87	8
English walnuts	8–16 meats	½	100	2.8	1.9	1.1	2.0	*	++	*	11	82	7
Sugar and Sweets:													
Sugar	1 T.	⅖	50	....	....	....	....	—	—	—	....	....	50
Honey	1 T.	1	100	0.3	0.3	0.4	2.0	—	+	—	1	....	99
Maple syrup	2 T.	1⅗	133	....	7.3	0.3	8.9	*	*	*	....	....	133
Molasses	2 T.	1⅗	133	1.0	14.7	1.5	22.6	*	+	*	4	....	129
Corn syrup	1¾ T.	1½	100	....	....	....	....	*	*	*	....	....	100
Gingerbread, plain	piece, 2×1⅔ +2 in.	2⅕	200	3.5	11.7	3.2	18.0	*	*	*	14	42	144
Sponge cake, 2 eggs, hot water	piece, 3×2¾ ×⅞ in.	1⅓	150	2.8	1.6	2.5	2.9	*	*	*	11	10	129

* From American Red Cross' "Text Book on Food and Nutrition." The chart is compiled by the Red Cross from various sources including Rose's "Feeding the Family," Macmillan Company; Rose's "Laboratory Manual"; and Sherman's "Food Products."

In the table above it was not considered advisable to include columns for Vitamins D, E, and G (P–P Factor or Principle) for the following reasons: Vitamin D is so greatly restricted in its distribution, being at present known in a half dozen foods, or fewer, which have been named in the text. Vitamin E is not believed to be a factor or an important factor, to say the most, in human abortion. Vitamin G is known to be closely associated with Vitamin B, found in all foods, or nearly all, in which Vitamin B is found. Furthermore, not much is known at present of the relative quantities of the P–P principle in the various foods in which it is found.

APPENDIX B

SUGGESTIONS FOR LABORATORY ASSISTANTS

The items of laboratory equipment, apparatus, and materials mentioned and to be used in Part IV of this book may be purchased either from Central Scientific Co., Chicago, or from General Biological Supply House, Chicago. There are also numbers of other firms which supply these items. Many of the items also may be had from local stores of the community. Pure cultures of bacteria may be had from American Type Culture Collection, 637 So. Wood St., Chicago, at $1.00 per culture.

Below are directions for preparation of a number of stains, media, solutions, etc., which are needed in Part IV.

METHYLENE BLUE STAIN

Make a saturated alcoholic solution of methylene blue by putting 3.5 grams of methylene blue crystals in 50 cc. of 95 per cent alcohol. Add to this solution 950 cc. distilled water in a large bottle. Shake vigorously every few minutes for an hour or two. Filter through filter paper. This stain keeps indefinitely.

NUTRIENT (OR PLAIN) AGAR

Dehydrated agar, in powdered form, may be had from Digestive Ferments Co., Detroit, Mich. It merely needs to be dissolved in distilled water, distributed in test tubes, then sterilized in the steam sterilizer (autoclave) and it is ready for use. It is packed in one-fourth pound and one-pound containers, which cost $2.25 and $8.00 respectively. A pound makes 19 liters of agar. This is the most convenient method of obtaining agar for a small laboratory. It is unnecessary to adjust reaction. Directions for use accompany the package.

LACTOSE BROTH

Lactose broth already made up and dehydrated, in powder form, may be had from Digestive Ferments Co., Detroit. When received it merely needs to be dissolved in distilled water. No adjustment of reaction is needed. It is packed by the manufacturers in one-fourth pound and one pound packages, and they sell at $1.75 and $6.00 respectively. A pound makes 34 liters of the broth ready for use. This is very convenient for the small laboratory.

BENEDICT'S QUALITATIVE SOLUTION

Weigh out the following:

Copper sulphate (pure crystallized)	17.3 grams
Sodium citrate or Potassium citrate	173.0 "
Sodium carbonate (crystallized)	200.0 "
(Or 100 grams anhydrous sodium carbonate)	

Dissolve the citrate and carbonate in 700 cc. of distilled water by heating. Filter through filter paper.

Dissolve the copper in 100 cc. of distilled water.

Slowly pour the last solution into the first, stirring constantly.

Cool, then add enough distilled water to make up to a liter.

This solution keeps indefinitely.

ARTIFICIAL GASTRIC JUICE

Dissolve 1 to 2 grams of pepsin, which may be had from any drug house, in 100 cc. of 0.4 per cent hydrochloric acid.

The 0.4 per cent hydrochloric acid may be made by putting 4 cc. of pure hydrochloric acid in 996 cc. of distilled water. If no still is had in laboratory, the distilled water of sufficient purity may be had from an ice factory for the asking.

NEUTRAL LITMUS SOLUTION

Put 25 cc. of N/10 potassium hydroxide in 75 cc. distilled water. To this mixture add 1 gram of Azolitmin powder.

Or the neutral litmus solution may be purchased from Central Scientific Co., Chicago, already made up in one pound bottles.

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